Evaluating the impact of coal mining on agriculture in the Delmas, Ogies and Leandra districts – With a specific focus on maize production
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A report by BFAP
Compiled for the Maize Trust

May 2012
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Abbreviations and Acronyms

BFAP  Bureau for Food and Agricultural Production
DALA  Department Agriculture & Land Administration
EIA   Environmental Impact Assessment
LSU   Livestock Unit
WWF   World Wildlife Fund

List of Standard Units

Ha    hectare
t/ha  Tons per hectare
pa    Per annum

Compiled by:

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Gerhard van der Burgh  BFAP
Llwelyn Coertzen  MENCO Consulting
Executive summary
Introduction

We, the Bureau for Food and Agricultural Policy (BFAP) was approached by the Maize Trust to compile a report which covers relevant issues regarding the impact of coal mining on the agricultural sector, but with specific focus on maize production in the Ogies, Delmas and Leandra districts. Since the requirements that were expressed by the Maize Trust are micro orientated, this study can be regarded as a pilot project to assess the impact of mining in the specified region.

The first phase of this report in particular, focused on literature that is already available as well as personal surveying in the region as required. An EIA (Environmental Impact Assessment) report that was compiled for mining activities in this region in October 2011 for the Springboklaagte mining group was used as a point of reference for this study, due to its relevance in the study area. This is a typical EIA report that was undertaken subject to the latest mining act and addresses issues like traffic, soil and land use, noise, air quality and surface water quality.

The BFAP report will focus on the following topics with regard to the entire pilot study area:

- The Economic impact on the area with reference to:
  - Loss in Maize production
  - Total summer cash crops losses
  - Grazing capacity reduction and economic impact
  - Traffic on roads and transport costs
- Environmental impact on the designated areas relating to:
  - Soil degradation
  - Water pollution
  - Biodiversity impacts as well as wetlands
  - Air pollution
  - Effects of coal dust
- The social issues within mining and the effects on agriculture
  - Labour recruitment & sustainability
  - Health issues
- Rehabilitation management of the mines.
Within the proposal to the Maize Trust, it was mentioned that issues like the loss in production, soil and air pollution and the rehabilitation of the land will be dealt with in phase one and issues regarding food security from a national perspective would not be addressed in this phase. The reason: the loss in production from this specific “pilot area” is not large enough to have a meaningful impact on grain and food markets in South Africa over the long run. The opposite was found to be true, with the reduction in hectares due to proposed mining activities it was found that approximately 450 000 tons of maize could potentially be lost from the pilot area alone. This is enough tonnage to have a meaningful impact on our BFAP baseline model, and the results will be shown in a later section.

**Mpumalanga province**

**Cash crop production**

![Figure 1: Mpumalanga - selected summer cash crop production per crop](image)

Source: SAGIS 2012 and sourced from the crop estimates committee

Figure 1 shows a reduction of 196 000 ha in the area planted to maize, while the area of soybeans increased with 148 000 ha in the same period. The reduction in maize plantings could be assigned to the rotational cropping with soybeans, as figure 2 shows the percentage change from 1997 to 2012. But in view of the total area planted to maize, soybeans, sunflower and sorghum it should be noted that the area decreased from 770 000 hectares to 680 000 hectares in 15 years, totalling a 90 000 hectare reduction.
Figure 2: Mpumalanga - percentage production reduction 1997-2012 in maize area planted
Source: SAGIS sourced from the crop estimates committee

Arable land potential for Mpumalanga

Map 1: Mpumalanga high-marginal potential arable land
Source: Map overlaid with CPlan (Conservation Plan) data, and compiled by MEnco consulting 2012
Based on the findings from map 1 and (Schoeman et el., 2002), it can be said that the entire Mpumalanga province has 12.1 % **high potential arable land** and 26.9 moderate potential arable lands (Table 1). Second to Gauteng, the province has some of the highest potential arable soils in the country, but due to current mining and new prospects for mining, this could soon have devastating effects on agricultural production as well as long term food security implications for the entire country.

**Table 1: Percentage arable land per province in capability classes**

<table>
<thead>
<tr>
<th>Percentage of province occupied by various arable potential classes</th>
<th>Very high(I)</th>
<th>High (II)</th>
<th>Moderate(III)</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern Cape</td>
<td>0.01</td>
<td>0.9</td>
<td>6.7</td>
<td>9.9</td>
</tr>
<tr>
<td>Free State</td>
<td>0.3</td>
<td>17.3</td>
<td>28.7</td>
<td></td>
</tr>
<tr>
<td>Gauteng</td>
<td>20.4</td>
<td>35.3</td>
<td>5.6</td>
<td></td>
</tr>
<tr>
<td>KwaZulu-Natal</td>
<td>0.01</td>
<td>5.7</td>
<td>24.9</td>
<td>11.1</td>
</tr>
<tr>
<td>Limpopo</td>
<td>0.7</td>
<td>16.8</td>
<td>20.2</td>
<td></td>
</tr>
<tr>
<td>Mpumalanga</td>
<td>12.1</td>
<td>26.9</td>
<td>12.2</td>
<td></td>
</tr>
<tr>
<td>North West</td>
<td>0.2</td>
<td>14</td>
<td>21.7</td>
<td></td>
</tr>
<tr>
<td>Western Cape</td>
<td>0.2</td>
<td>6.9</td>
<td>6.8</td>
<td></td>
</tr>
<tr>
<td>South Africa</td>
<td>0.02</td>
<td>1.8</td>
<td>10.6</td>
<td>11</td>
</tr>
</tbody>
</table>

Source: Schoeman J.L et al. 2002

Based on statistics from AGIS (2011) it was calculated that in the year 2007, Mpumalanga’s cultivation equalled a total of 993 301 hectares. It is quite alarming to note from map 2, that if current mining areas are overlaid with the latest field crop boundaries, a total of 326 022 ha will be lost to mining and a further 439 577 ha if the prospecting area is also transferred, totalling a staggering 765 599 hectares potentially transferred is all the mining takes place as indicated by the DALA (Department Agriculture and Land Administration) in McCarthy et el, 2009.

**Table 2: Total cultivation per province**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultivation Type</td>
<td>FS</td>
<td>GP</td>
<td>KZN</td>
<td>LP</td>
<td>MP</td>
<td>NC</td>
<td>NW</td>
<td></td>
</tr>
<tr>
<td>High cultivation</td>
<td>1064183</td>
<td>26995</td>
<td>0</td>
<td>141252</td>
<td>159773</td>
<td>27274</td>
<td>936800</td>
<td></td>
</tr>
<tr>
<td>Medium cultivation</td>
<td>1738863</td>
<td>165619</td>
<td>159133</td>
<td>199424</td>
<td>579197</td>
<td>2996</td>
<td>641205</td>
<td></td>
</tr>
<tr>
<td>Low cultivation</td>
<td>652712</td>
<td>81953</td>
<td>131414</td>
<td>255540</td>
<td>204736</td>
<td>156722</td>
<td>384404</td>
<td></td>
</tr>
<tr>
<td>Old Fields</td>
<td>170744</td>
<td>1934</td>
<td>3291</td>
<td>21369</td>
<td>0</td>
<td>2180</td>
<td>69218</td>
<td></td>
</tr>
<tr>
<td>Pivot Irrigation</td>
<td>121540</td>
<td>18650</td>
<td>40110</td>
<td>125183</td>
<td>33298</td>
<td>72546</td>
<td>67865</td>
<td></td>
</tr>
<tr>
<td>Small scale farming</td>
<td>23919</td>
<td>1940</td>
<td>255963</td>
<td>524540</td>
<td>16297</td>
<td>282</td>
<td>184244</td>
<td></td>
</tr>
<tr>
<td>Smallholding</td>
<td>0</td>
<td>3913</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Smallholding &lt; Sha</td>
<td>0</td>
<td>13932</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>3771961</td>
<td>314936</td>
<td>589911</td>
<td>1267308</td>
<td><strong>993301</strong></td>
<td>262000</td>
<td>2283736</td>
<td></td>
</tr>
</tbody>
</table>

Source: AGIS (2011)
Current Mining and Prospecting

According to the maps made available in various online publications and the Department of Agriculture and Land Administration, mining and prospecting areas cover an extensive part of Mpumalanga Province. This is a frightening site and causes much concern for the future existence and state of agriculture in Mpumalanga. According to Mr. Jan Venter, these maps and GIS data layers should be interpreted in a cautious way. The interpretation according to Mr. Venter is as follow:

- **Mining or Current mining** include all areas on which some form of mining operations exist or where there are mining rights. Some of these mines are operational and some are not.
- **New mining applications or Prospecting** areas include all areas for which applications for prospecting permits have been received by the relevant departments and which have either been approved or are still being processed.

It should be noted that although large farm portions are shown to be covered by mining operations or prospecting areas, only small areas of these farms will be subjected to mining and or prospecting. Applications for prospecting and mining rights are done over large areas in order to obtain a permit usually applicable only to a much smaller portion or area within the larger area. In this sense it might seem as if the maps displayed are an over exaggerated picture of the actual reality, but there is still room for concern given that the mine will have to buy the entire piece of land. It is not a given that the mine will lease back the land not mined on.

Awareness of the current situation that potentially threaten the agricultural industry in Mpumalanga and ultimately South Africa, is necessary to enable all the relevant stakeholders to act and ensure that land that has previously been set aside for agricultural use is protected. This will bring about a balance between the uses of all our country’s natural resources in a sustainable way.
Map 2: Field crop boundaries overlaid with current & prospecting mining activities
Source: DALA 2009, AGIS 2011, compiled by TIMS consulting for BFAP

**Pilot study area**

Map 3: Pilot study area containing the field crop boundaries, with current & prospected mining areas. Delmas, Ogies and Leandra
Source: From Map 2, Compiled by TIMS for BFAP 2012
Map 3 illustrates that the pilot area has an approximated total area of 170,763 ha, of which 99,518 ha is made up of high potential arable land and 38,020 ha from the area is classified as moderate potential arable land. Of the 170,763 hectares of land, 84,428 hectares are considered to have high to low cultivation taking place on them and a further 5,956 hectares can be regarded as pivot irrigated land.

The total high, medium and low cultivation hectares influenced by current mining is 27,431, 17,178 and 2,495 ha respectively, as well as 3,180 ha from pivot irrigation. Then from the proposed prospecting areas another 13,485, 12,448 and 638 ha, within the same field crop boundaries as mentioned, and 2,488 for irrigation. This was calculated by TIMS consulting using ARC GIS mapping, with the field crop boundaries data provided by AGIS, 2011.

Map 4 (with a spot image background) displays the amount of mining and prospecting taking place in the area.

Map 4: Spot view of pilot area showing current and prospecting areas as well as the proposed Springboklaagte colliery.
Source: (By: Lotter M) for DALA 2009, compiled using Google earth by MENCO for BFAP 2012
Economic impact in the study area

Based on the finding from the above mentioned maps, further calculations were made. The data from the maps are potential hectares only, as true hectares cannot yet be verified by any of the governmental departments. Evaluating the true economic impact of mining will have to go further than the pilot area as externalities such as the pollution of the countries scarce water sources and air pollution cannot be excluded from making a cost analyses.

The pilot area will give us an estimate on the potential of agricultural land, based on production potential averages for the area, and certain losses that in future will have to be considered by the “reclamation farmers”. What is a “reclamation farmer”? This is a term created for the future farmers in the area, as the current arable agricultural land will potentially be transformed by mining activities.

After the mines have left, you should find “rehabilitated” land, which according to fin24 “the ruling confirms the need to rezone land on which mining takes place” i.e. this land will now be regarded as mining land. But according to Section 40 of the Minerals Act “should be in the same state as what it was before mining took place” and “failure to do so is enforced through the criminal sanction” (Sections 5(2), 8(1), 38, 39(1), 40 and 60(a) of the Minerals act and draft reg. 5.7.8 GN 275 read with section 63(5) of the Act) (Fuggle & Rabie, 2000).
The Minerals act further provides for the “expropriation of land where the use of land for mining purposes prevents or hinders the proper use of such land for farming purposes.” (Sections 42(1)(a) and 42(2)) (Fuggle and Rabie, 2000). So these farmers will farm on mining land, with at least half the potential which it had before the mines were there and technically not on agricultural land, hence the phrase reclamation farmers and great confusion of ownership.

The topics below will focus on the study area as displayed and calculated in Map 3, but some external economic impacts, such as the environmental economic aspects will also follow thereafter. It was calculated that an approximated total of 79,967 ha (map 3) of the current cultivated land in the Delmas, Ogies and Leandra district will potentially be taken over by the mines. The time frame for this is unknown, but we would rather be pessimistic about the situation, and take the worst case scenario where all the land is taken up by mining over the next ten to twenty years.

**Potential loss in maize production**

The loss in production will have to focus on two scenarios. The first table will show the loss in production, due to only the current mining and the second will show the effect if the area taken for prospecting is also taken into consideration. The tables were compiled based on the average of 75% (figure 3) maize cropping for the Mpumalanga, and further 25% soybeans. The terms “high” or “medium” cultivation refers to the intensity of the crop cultivation that was seen by the authors.

![Average production 2008-2012, Mpumalanga](image.png)

**Figure 3:** Average share in production for Mpumalanga from the four summer crops
Source: SAGIS 2012, compiled by BFAP 2012
Table 3: Soil potential and crops cultivated for the area based on Springboklaagte results

<table>
<thead>
<tr>
<th>Product</th>
<th>Arable potential</th>
<th>Potential yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize dry land</td>
<td>high</td>
<td>7-9t/ha</td>
</tr>
<tr>
<td>Maize irrigated</td>
<td>high</td>
<td>11-15t/ha</td>
</tr>
<tr>
<td>Maize dry land</td>
<td>moderate</td>
<td>6-8t/ha</td>
</tr>
<tr>
<td>Soybeans dry land</td>
<td>high</td>
<td>2-2.5t/ha</td>
</tr>
<tr>
<td>Soybeans dry land</td>
<td>moderate</td>
<td>1.5-2t/ha</td>
</tr>
</tbody>
</table>

Source: Steenekamp P.I. 2011.

Based on personal correspondence with farmers in the area, it was also confirmed that these yields are the norms in the area, due to high potential fertile soils, and enough heat units, allowing for optimum growth. It was also taken that the area receives an average of 650 – 700mm of rain, Steenekamp (2011: 54).

Table 4.1: Maize tonnage losses due to current mining

<table>
<thead>
<tr>
<th>Loss in maize production if current mining takes place</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hectares</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>High cultivation</td>
</tr>
<tr>
<td>Medium cultivation</td>
</tr>
<tr>
<td>Low cultivation</td>
</tr>
<tr>
<td>Pivot irrigation (assuming 40% maize)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>

Table 4.2: Maize tonnage losses due to prospecting also being transferred

<table>
<thead>
<tr>
<th>Loss in maize production if prospecting also takes place</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hectares</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>High cultivation</td>
</tr>
<tr>
<td>Medium cultivation</td>
</tr>
<tr>
<td>Low cultivation</td>
</tr>
<tr>
<td>Pivot irrigation (assuming 40% maize)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>

Source: Computed from map 3 and Table 3 - own calculations

It can thus be said that in the long term, an estimated 20 years from now, approximately 447 581 tonnes of maize could be out of production from this area, if all the current & imposed future mining (on prospected areas) takes place as map 1 displayed. It can also be noted that most of these mines take up to 10-15 years to be complete their mining, and then only does the final rehabilitation start.
Potential remainder summer cash crop losses

To simplify the calculations in the area, we assumed a 25% rotation of maize with soybeans; it can therefore be calculated that approximately 49 889 tons of soybeans would also be removed due to the same activities as calculated for the maize reductions.

Table 5: Potential soybean tonnage reduction

<table>
<thead>
<tr>
<th></th>
<th>Hectares</th>
<th>Potential t/ha</th>
<th>Ha if 25% soy</th>
<th>Tonnage produced</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Cultivation</td>
<td>27 431.0</td>
<td>2.5</td>
<td>6 857.8</td>
<td>17 144.4</td>
</tr>
<tr>
<td>Medium Cultivation</td>
<td>17 178.0</td>
<td>1.9</td>
<td>4 294.5</td>
<td>8 159.6</td>
</tr>
<tr>
<td>Low Cultivation</td>
<td>2 495.0</td>
<td>1.5</td>
<td>623.8</td>
<td>935.6</td>
</tr>
<tr>
<td>Pivot Irrigation (40% Soybeans)</td>
<td>3 180.0</td>
<td>4.0</td>
<td>1 272.0</td>
<td>5 088.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>50 284.0</strong></td>
<td><strong>4.0</strong></td>
<td><strong>13 048</strong></td>
<td><strong>31 327.6</strong></td>
</tr>
</tbody>
</table>

Loss in Soybean production if prospecting also takes place

<table>
<thead>
<tr>
<th></th>
<th>Hectares</th>
<th>Potential t/ha</th>
<th>Ha if 25% soy</th>
<th>Tonnage produced</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Cultivation</td>
<td>13 485.0</td>
<td>2.5</td>
<td>3 371.3</td>
<td>8 428.1</td>
</tr>
<tr>
<td>Medium Cultivation</td>
<td>12 448.0</td>
<td>1.9</td>
<td>3 112.0</td>
<td>5 912.8</td>
</tr>
<tr>
<td>Low Cultivation</td>
<td>638.0</td>
<td>1.5</td>
<td>159.5</td>
<td>239.3</td>
</tr>
<tr>
<td>Pivot Irrigation(40% Soybeans)</td>
<td>2 488.0</td>
<td>4.0</td>
<td>995.2</td>
<td>3 980.8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>29 059.0</strong></td>
<td><strong>4.0</strong></td>
<td><strong>7 638</strong></td>
<td><strong>18 561.0</strong></td>
</tr>
</tbody>
</table>

Source: Computed from map 3 and further own calculations

To quantify the potential losses for the area, we used the figures from the table 4, combined with the BFAP Baseline futures prices to get to an approximate figure that will show us just how much revenue in rand value will be generated with maize production in the study area, if no mining activities were to take place. The cost of production (or input costs) was deducted using a 4% yearly increase in order to calculate the maize production revenue.
The results for the potential revenue for maize tonnage produced over a period of ten years are displayed in Table 6. Based on the revenue for the time frame of ten years, in which the pilot study area would not be affected by mining, a total of R 3 497 343 213 could potentially be made due to maize production alone.

Table 6: Potential yearly income for maize production in the pilot study area.

<table>
<thead>
<tr>
<th>Year</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Projected Safex price</td>
<td>1773</td>
<td>1841</td>
<td>1923</td>
<td>2245</td>
<td>2031</td>
</tr>
<tr>
<td>Total Tonnage (4.5t/ha - 8.5t/ha, from Table 4), with 1.5% yearly increase in t/ha</td>
<td>454295</td>
<td>461109</td>
<td>468026</td>
<td>475046</td>
<td>482172</td>
</tr>
<tr>
<td>Hectares planted in pilot area</td>
<td>79343</td>
<td>79343</td>
<td>79343</td>
<td>79343</td>
<td>79343</td>
</tr>
<tr>
<td>Average cost per hectare</td>
<td>7000</td>
<td>7350</td>
<td>7718</td>
<td>8103</td>
<td>8509</td>
</tr>
<tr>
<td>Total cost of production in pilot area</td>
<td>555 401 000</td>
<td>583 171 050</td>
<td>612 329 603</td>
<td>642 946 083</td>
<td>675 093 387</td>
</tr>
<tr>
<td>Total maize net revenue for pilot area</td>
<td>R250 063 395</td>
<td>R265 568 984</td>
<td>R287 808 269</td>
<td>R423 741 887</td>
<td>R304 203 692</td>
</tr>
<tr>
<td>Year</td>
<td>2018</td>
<td>2019</td>
<td>2020</td>
<td>2021</td>
<td>2022</td>
</tr>
<tr>
<td>Projected Safex price</td>
<td>2310</td>
<td>2250</td>
<td>2329</td>
<td>2350</td>
<td>2421</td>
</tr>
<tr>
<td>Total Tonnage (4.5t/ha - 8.5t/ha, from Table 4), with 1.5% yearly increase in t/ha</td>
<td>489404</td>
<td>496745</td>
<td>504197</td>
<td>511760</td>
<td>519436</td>
</tr>
<tr>
<td>Hectares planted in pilot area</td>
<td>79343</td>
<td>79343</td>
<td>79343</td>
<td>79343</td>
<td>79343</td>
</tr>
<tr>
<td>Average cost per hectare</td>
<td>8934</td>
<td>9381</td>
<td>9850</td>
<td>10342</td>
<td>10859</td>
</tr>
<tr>
<td>Total cost of production in pilot area</td>
<td>708 848 056</td>
<td>744 290 459</td>
<td>781 504 982</td>
<td>820 580 231</td>
<td>861 609 242</td>
</tr>
<tr>
<td>Total maize net revenue for pilot area</td>
<td>R421 655 417</td>
<td>R373 346 730</td>
<td>R392 954 986</td>
<td>R382 054 695</td>
<td>R395 945 158</td>
</tr>
</tbody>
</table>

Source: BFAP calculations based on table 4

Table 7 provides an example of the “economies of scale “reduction in the area. If for example the person has 1000 ha, and the mine buys 400, will the remaining land still justify his machinery costs and in turn, what effect will this have on his farm as an economic unit? This was only an example drawn on direct machinery costs and factors such as overheads, family living expenses and the decrease in total net farm income was not yet calculated for the area.

**The potential exists to take a specific farm, relating to the study area, and build it into our farm benchmarking model, this will show the net effect on total farm income, as the persons hectares decrease. Due to this being a pilot study for the entire area of 170 000 ha based on maize production primarily, this was not calculated.**
### Table 7: Indication of economies of scale reduction in maize cultivation equipment

<table>
<thead>
<tr>
<th></th>
<th>Capital Cost</th>
<th>Cost from reduction in Ha</th>
<th>Cost from reduction in Ha</th>
<th>Cost from reduction in Ha</th>
<th>Cost from reduction in Ha</th>
<th>Trucks &amp; handling</th>
<th>Cost from reduction in Ha</th>
<th>Total reduction per hectare</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R 2 500 000</td>
<td>R 3 500 000</td>
<td>R 2 200 000</td>
<td>R 1 100 000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Payment over 10 years, 11% interest</td>
<td>R 4 245 036</td>
<td>R 5 943 050</td>
<td>R 3 735 631</td>
<td>R 1 867 816</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Pmt per year, for 10 years</td>
<td>R 424 504</td>
<td>R 594 305</td>
<td>R 373 563</td>
<td>R 186 782</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cost per ha on 1000 ha, for 10 years</td>
<td>R 425</td>
<td>R 425</td>
<td>R 594</td>
<td>R 594</td>
<td>R 374</td>
<td>R 374</td>
<td>R 187</td>
<td>R 187</td>
</tr>
<tr>
<td>cost per ha on 800ha</td>
<td>R 531</td>
<td>R 106</td>
<td>R 743</td>
<td>R 149</td>
<td>R 467</td>
<td>R 93</td>
<td>R 233</td>
<td>R 47</td>
</tr>
<tr>
<td>cost per ha on 600ha</td>
<td>R 708</td>
<td>R 177</td>
<td>R 991</td>
<td>R 248</td>
<td>R 623</td>
<td>R 156</td>
<td>R 311</td>
<td>R 78</td>
</tr>
<tr>
<td>cost per ha on 400ha</td>
<td>R 1 061</td>
<td>R 354</td>
<td>R 1 486</td>
<td>R 495</td>
<td>R 934</td>
<td>R 311</td>
<td>R 467</td>
<td>R 156</td>
</tr>
<tr>
<td>cost per ha on 200ha</td>
<td>R 2 123</td>
<td>R 1 061</td>
<td>R 2 972</td>
<td>R 1 486</td>
<td>R 1 868</td>
<td>R 934</td>
<td>R 934</td>
<td>R 467</td>
</tr>
</tbody>
</table>

Source: Compiled by BFAP

### Grazing capacity reduction and economic impact

For the purpose of this study, grazing losses was not the core focus. But due to the high value of the grazing capacities in the Highveld, a quick summary was given to evaluate the potential of these fields in relation to other grazing areas in the country.
Table 8: Cost for 1:1 LSU (Livestock Units) carrying capacity

<table>
<thead>
<tr>
<th></th>
<th>ha needed for 1 LSU</th>
<th>Heads of cattle on 500 Hectares</th>
<th>Add Ha needed to = Highveld capacity</th>
<th>Est. cost per ha in province</th>
<th>At what cost</th>
<th>Relocation cost to equal Highveld</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highveld</td>
<td>1</td>
<td>500.0</td>
<td>none</td>
<td></td>
<td></td>
<td>40800</td>
</tr>
<tr>
<td>S Free State</td>
<td>7</td>
<td>71.4</td>
<td>3000</td>
<td>6800</td>
<td>20400000</td>
<td>48000</td>
</tr>
<tr>
<td>E Free State</td>
<td>5</td>
<td>100.0</td>
<td>2000</td>
<td>13000</td>
<td>26000000</td>
<td>52000</td>
</tr>
<tr>
<td>North West</td>
<td>7</td>
<td>71.4</td>
<td>3000</td>
<td>7500</td>
<td>22500000</td>
<td>45000</td>
</tr>
</tbody>
</table>

Source: compiled by BFAP

Table 8 has a 1:1 ratio, which is very high. This was based on the correspondence with farmers in the area. They noted that this is possible when planted pastures and harvested maize lands are used as supplement feed in the winter months.

Table 9: Cost for 1:2 LSU carrying capacity

<table>
<thead>
<tr>
<th></th>
<th>ha needed for 1 LSU</th>
<th>Heads of cattle on 500 Hectares</th>
<th>Add Ha needed to = Highveld capacity</th>
<th>Est. cost per ha in province</th>
<th>At what cost</th>
<th>Relocation cost to equal Highveld</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highveld</td>
<td>2</td>
<td>250</td>
<td>none</td>
<td></td>
<td></td>
<td>17000</td>
</tr>
<tr>
<td>S Free State</td>
<td>7</td>
<td>71.4</td>
<td>1250</td>
<td>6800</td>
<td>8500000</td>
<td>19500</td>
</tr>
<tr>
<td>E Free State</td>
<td>5</td>
<td>100</td>
<td>750</td>
<td>13000</td>
<td>9750000</td>
<td>19500</td>
</tr>
<tr>
<td>North West</td>
<td>7</td>
<td>71.4</td>
<td>1250</td>
<td>7500</td>
<td>9375000</td>
<td>18750</td>
</tr>
</tbody>
</table>

Source: compiled by BFAP

Table 9 shows a more averaged approach to the area, and the cost to relocate and purchase the same value of land in another province.

**Losses due to increased criminal activities**

Quantifying the losses for the study area is not possible at the moment, due to the unavailability of reports and incidents in the public domain. But from personal correspondence with farmers in the area, it came to our attention that theft of livestock, maize cobs and electrical cable is increasing at an alarming rate. This could have a negative effect on maize production due to increased security costs such electric fencing, guards, costs to armour electric pumps and increased insurance premiums.

It should be noted that the increased criminal activities are not directly related to the increase in mining activities, as the mining industry are also severely affected by this. It’s rather a matter of concern for the entire province, and the sustainability of economic production.
Traffic on roads and related effects

The transport section was compiled by: BN Roberts (Pr Eng MBA) - Moyeni Professional Engineering

Based on a desktop approach and experience in the field of transport economics, some conclusions could be drawn from the pilot study area. But due to information and data constraints, an in depth analysis is currently not possible, as more details with regards to the mining activities would be needed. Some of the findings include the following:

The transport economic aspects include:

- Travel costs including fixed and operating costs.
- Travel time costs
- Accident costs
- Outsourcing costs

Road network

The N12 is in excellent condition and as in the Bethal / Hendrina area lends itself for the export of mining products to Gauteng and to the Maputo port. The N17 is a relatively poor condition except the link towards Gauteng.

Of the internal roads, the R50, R548 and the R29 offer good linkages. The R580 is a secondary route in the middle of the study area. The northern section of the study area has no Provincial roads to link activities.

The existing and future internal roads related to the mining activities will no doubt change the road network to include many smaller roads.

Road condition

Except for the N12, most routes are in a relatively poor condition and require immediate maintenance.

Farming transport costs

Currently the fixed costs are assumed to be R250 000 per annum per truck and R30 per km. This is also taken that farmers does not make use of outsourcing.

Transport impact of mining activities on the agriculture industry

As shown on the map 3 - Pilot study area – “Field crops lost due to mining and prospecting”, it expected that:

- Mining activities will, over 20 years, take over most of the agriculture activities.
- During the change, farmers will move off the land with the associated reduction in farming-related and increasing mining-related transport flows.
The post-mining reinstated land will not be used for maize farming but instead rehabilitated for cattle farming.

- The 35t trucks related to mining are normally larger than the 10t farming trucks. This means that the axle loads on the roads will be some 10 times higher than is the current situation. This structural loading change is expected to reduce road life to a few years. As is the case with the coal transport to the Eskom power stations, the new mines will need to provide a major maintenance budget in their planning.

- Should the mines not maintain the roads they impact over the next 20 years, farming transport costs could double to R500 000pa and R40/km.

- Over time, the economies of scale for farming will rapidly diminish. At some stage farmers may elect to outsource their major transport needs. However, since the farming activities within the study are expected to reduce with some 20 percent of current day activities, operators may not be available or if available will be expensive since there are little economies of scale present.

**Concluding effects**

- Due to the 35t trucks related to mining, roads will require major maintenance budgets to keep the road conditions in an acceptable state; a requirement for general, but farming transport in particular.

- Travel costs for farming are expected to double over time to some R500 000pa and R40/km (R2012 Rand)

- The costs related to accidents and general safety are difficult to quantify but will exponentially increase should the roads not be maintained in a good condition including road signs and markings, guards rails, bridge railings and the like.

**Environmental impact on the designated area, and further downstream**

This section will focus on the environmental impacts of mining in the Highveld region. The true economic impact in the designated area will have to focus on these external environmental economic issues, as their repercussions are far reaching, and could possibly affect the greatest part of agricultural activities in Mpumalanga as well as Limpopo province.

These issues could not be confined to the study area, as very little research has been done in this specific region. But literatures from similar regions were drawn, and used as illustrations of the potential overall impacts of mining on the agricultural land.
Soil degradation

“Soil formation takes thousands of years and, by only restoring a fraction of the original land capability, future generations are deprived of the choices that are available to this generation”. (Aken, Limpitlaw, Lodewijks and Viljoen, 2005:4)

As mentioned at the beginning of the document, Mpumalanga has the second highest potential arable land in the country, and the pilot study area lies exactly in this area. To compute the economic impact of soil degradation is a project on its own, but making use of literature currently available on this topic, provides a general indication of the potential impacts that coal mining could have on arable land in the study area.

Open cast mining

The EIA report from the proposed Springboklaagte colliery was used as an example, due to its relevance in the pilot study area. The findings from this soil assessments reports can serve as a benchmark for the pilot area, as most the soils in the pilot study area (58.3%) are classified as high potential arable land and 22.3% as moderate (sourced from Map 3). To understand the effects of opencast mining on the arable land, we included certain literature from the EIA report. First the arable agricultural value of the soils are described, then the stripping process which takes place prior to the physical mining. According to Steenekamp (2011:55)

It is important to bear in mind that the natural soil horizons developed over thousands of years in a specific sequence and is the result of soil genesis (weathering) of the parent rock driven by climatic conditions (temperature and moist) within a specific topography. Stripping and replacing of soil will always result in a moderate to severe disturbance of the natural balances in the soil’s physical and chemical properties. This implies that even with precise execution of well-defined rehabilitation procedures, a degradation from pre-mining to post-mining land capability is unavoidable.

Most rehabilitation specialist argue that they can rehabilitate the soil potential back to 70% of its pre-mining potential as described by Steenekamp (2011:55) “The stripping procedures aim, with consideration of practical limitations, to reconstruct the original horizons sequences. That will be the only way to re-establish 70% or more of the pre-mining land capability”. They reckon that most of this “70%” could be achieved by separate stockpiling and following exact rehabilitation procedures. Stockpiling is a process in which the different layers of topsoil (A-G) are removed separately and dumped on separate sites, to in future replace them back as the final topsoil, Steenekamp (2011:56,57). Parts of the process as described by the report include the following:

- The A and B-horizon should be stripped and stockpiled separately as specified by the Chamber of Mines (Guidelines for the rehabilitation of mined land, Section 3.2). Each stockpile should therefore consist of a section for both the A and B-horizons. The A and B-horizon sections should be marked with a signboard.
• The A and B-horizons should be replaced in the same sequence on top of the soft overburden material. The fairly higher organic carbon content of the A horizons provides a buffer against compaction and hard setting. The A-horizons also serves as a seed source which will enhance the re-establishing of natural species. When B-horizons are replaced on the surface it tend to seal and compact severely which increases runoff and triggers erosion.

• The soil fertility status should be determined by soil chemical analysis after levelling (before seeding/re-vegetation) and soil amelioration should be done accordingly as recommended by a soil specialist in order to correct the pH and nutrition status once off.

It was mentioned that if no proper guidance and enforcement on these rehabilitation measures are applied, 70-90% of the pre-mining soil potential will be lost, even if the correct depth is allowed for, Steenekamp (2011:68,69).

Real effects of open-cast mining and soil degradation

The question then remains, how much of the mines do really rehabilitate in this manner? Besides the rehabilitation, there is no evidence to prove that you can get these soils back to its pre-mining potentials; in fact the contrary is given. According to Aken et al., (2005:4)

Pre-mining environment consists of bio diverse grassland of varying agricultural potential. Through the rehabilitation process, land is returned to low levels of biodiversity as rehabilitation programmes preferentially use commercially available seed, with high nutrient and water requirements. Through over-fertilisation, grass monocultures are promoted, preventing the re-establishment of bio diverse pastures. For example, a commonly used rehabilitation grass, Eragrostis sp., secretes a hormone from its roots prohibiting the germination of other seeds. This problem has been detected by environmental audits in many rehabilitated colliery landscapes. Once the high input regime, established during the rehabilitation programme ceases, after five years or so, the grass cover often deteriorates.

This does not even mention maize production or feasible cash crop production. Mono specific grass-lands and pastures (such as Eragrostis) are according to Aken et el. (2005:4) are not able to sustain economic grazing systems, due to their high input costs.

Future cash crop production

The effects of soil losses on rehabilitated lands are at the moment not fully appreciated, as these effects may be delayed for several years once rehabilitation is completed, some only become evident 15 years later. Due to the erosion, salt mitigates upwards through rehabilitated surfaces, and has a negative effect on re-established vegetation (Aken et al., 2005:5).
The question that everyone then asks, “will rehabilitated land come back into maize production?” is more or less self-explanatory if you look at the findings of Aken et al. (2005:5), as they wrote the following:

*Replacement of thick layers of topsoil is not necessarily a recipe for crop success, as was previously thought. Compaction caused by machinery during the rehabilitation process is a factor, as is the possible hard setting nature of soils when moved wet. Rehabilitation may be more prone to failure on compacted deep soils than on compacted shallow soils as, in the latter; plants are able to extract water from the underlying spoils which do not compact readily. Red soils, with a clay content of less than 28%, are common on the Highveld and are highly compactable when replaced during the rehabilitation process. This is especially true if the soils are moved when they have a soil moisture content in excess of 10%. The rehabilitation process often, unwisely, uses graders to smooth off rehabilitated surfaces to achieve a pleasing aesthetic landscape. The high bearing load on the wheels of this machinery promotes soil densification. Plant roots cannot penetrate such dense soils and water in underlying spoils cannot be extracted.*

Although a compacted soil profile may contain soil water at field capacity, the inability of the roots to penetrate deeply into these soils means that the stored water is unavailable for plant growth. Under such conditions, one metre of soil is replaced, but only half a metre is available for growth. **Even deep-ripping of re-emplaced soils has proved ineffective.** Hard setting follows the first rains after deep ripping due to the lack of organic materials and microbes in the soils. **This arises in soils stored too long, due to a lack of aeration, reducing the likelihood of crop re-establishment on previously mined land.**

**Direct effects of farmers next to mines**

Dr Koos Pretorius, a farmer in the Middelburg district makes use of precision equipment such as combine monitors. He noted that his harvesting report maps showed a clear reduction of at least 1.5 – 2t/ha in the area which is within 10-20meters from the road. This maize field lays next to a coal mine and subsequently have the effects from the trucks that transport the coal; they primarily make use of this road. (Personal correspondence, 2012). Due to the time restriction, the charts could not be included, but they can be made available by the end of June 2012, as the farmers is still harvesting. Figure 4 shows similar effects from the mine dust as what Dr Pretorius said. This figure was obtained from the WWF (World Wildlife Fund – SA). The black coal dust is clearly visible next to the road.

Dr Pretorius also mentioned the effects which the mine dust had on parts of his crop are quite severe. When it rained and the mine dust washed in, part of the maize crop was “burned” or turned yellow as a sign of crop stress and death.
Underground mining and related effects

The effects of under-ground mining in relation to open-cast mining could be just as severe. Again looking at the Springboklaagte EIA example, we could not help but to notice that in the soil assessment study little was said about the underground mining areas and their “cultivated land losses”. According to Steenekamp (2011:7) the proposed Springboklaagte mining project will consists of 6 open pits with a total of 261.58 ha and the underground mining of the “2-seam, 4-upper, 4 lower and 5-seam” has a total of 1492.22 ha.
It then came to our attention that some EIA’s do not include the underground mines in their calculations of pre-mining arable agricultural potential. At the top of figure 5, block 13 is seen, and within this block a light green border represents the boundary of the proposed underground mining section.

Arable land is shown on the maps (e.g. Figure 6b), but the hectares of cultivated land potentially transformed by underground mining (figure 6a), is not shown as a reduction in crop losses, compared with the open-pit mining calculations. Figure 7 shows how the open-pit mines are displayed with their crop type and hectares, but as the blue circle shows on the same figure, no calculations are made that will show to what extent the proposed underground mine might affect the topsoil.

Figure 5: Proposed Springboklaagte colliery – boundaries of open-pits and underground mines (light green lines).
Source: Steenekamp (2011:8)

Figure 6a & b: (a) Underground mining “shaft” developments, (b) Arable potential for the proposed areas.
Source: (a) Oosthuizen (2011:13) and (b) Steenekamp (2011:8)
Figure 7: Illustration of open-pit mining area (block 6, outlined in red) - cultivation potential vs. Underground mining area (drawn in blue border) – with cultivated fields, but not included as “pre-mining land use”.
Source: Steenkamp (2011:53)

The effect of underground mining is an aspect that receives very little attention in the EIA’s, as very little arable topsoil will be disturbed during the direct mining process. But the true effects are only seen some years later when these underground structures give way. After reading the literature from Aken et al. (2005:6), we would also argue that underground mining could contribute to the destruction of high potential arable land.

According to Aken et al., (2005:6):

*Subsidence* (sinking or subsiding) *is a problem that has not received adequate attention. The impacts of land subsidence have not been felt as originally predicted by models. Many board and pillar sections are between 50 and 60 years old and experience indicates that serious subsidence will only occur after between 100 and 120 years. As the old, closed sections age, mass subsidence may occur due to pillar runs and the collapse of whole areas.*
A truism is that all underground excavations will collapse over time and pillars will spall. Where these excavations are near surface, ratholing and subsidence will follow. Even where such excavations are not very shallow, as in Springs on the East Rand, sinkholes have propagated 65 m up to surface (Stacey & Page, 1983).

From figures a-c, it is quite obvious that the effects of underground mining are just as detrimental as the attempts to rehabilitate open-cast mines. The point being that arable land will be lost for centuries to come, if nothing is done to protect high potential arable land.

Figure 8(a)(b)(c): (a) A collapsed, burning coal mine, (b) Acidic, iron-rich water filling a collapsed coal mine, (c) Barren, sulphate-encrusted soil caused by seepage of acidic water from a flooded coal mine.

This concludes the argument that all the soils bought by the mines are for the purposes of this study regarded as “lost”, i.e. not coming back to maize production in the next 50+ years.
Water pollution, biodiversity impacts as well as wetlands disruptions

Effects of mining on Water Quality

Overview

Mining activities exert their effects on water quality during construction and operational phases and in many cases, also at abandoned mines post operational. This is mainly due to extremely poor infrastructure, management and legislative control. The negative impacts of coal mining has been documented over years and described “Coal mine drainage adversely affects the aesthetic appearance of streams and rivers, destroys the living organisms that inhabit them and hence reduces their self-purification power, and makes streams unfit for domestic, industrial and agricultural use, requiring surface waters to be extensively treated before they are suitable for such uses” (Kemp, 1967). The effects of mining impacts can be as far reaching as 18km downstream from the impacted site and if no mitigated measures are put in place, can have long lasting effects (Dallas & Day, 2004).

Study area within Upper Olifants catchment

Map 6: Upper Olifants catchment and pilot study area

As data was a limiting factor, with very few comprehensive monitoring data sets available for the past 20 years in the study area, no comparisons and conclusions could be established with regards to water quality data. A more comprehensive overview of the entire Olifants catchment will provide more substantial data, but was outside the scope of this study.
Therefore **appendix A** provides an assessment overview of the catchment, and pollution related effects on the entire catchment, with some effects mentioned in the pilot area.

**Coal mining related pollution in the Highveld**

According to McCarthy et al. (2009:1), the Witbank area provides an opportunity to examine the longer term impacts of coal mining, as mining has been in operation there for over a 100 years. A summary of their findings include:

*The impacts include sterilization of land due to collapse and acidification of soils, but the most severe problem is water pollution, which is high and rising. Water in the Middelburg Dam exceeds the quality limits for water for human consumption, and Witbank dam is trending in the same direction. The pollution levels are still rising, notwithstanding mitigation measures that have been taken.*

Detailed findings from McCarthy et al (2009:1), shows the severity of the situation which is worsening every year. The main culprits seem to be the mining, the inactive sewerage works and in the end agriculture also contributes a part to chemical pollution. Inclusions from their findings are also shown in **appendix A**.

**One of the most severe impacts – AMD (Acid Mine Drainage)**

The impacts that acid mine drainage exerts on a receiving stream is dependent on the nature of the receiving water body and is related to the buffering capacity of the receiving stream (Ward, Canton, & Gray, 1978) (Dallas & Day, 2004). Larger and faster flowing streams are less prone to impacts by the effects of acid mine drainage. The rocks and soil of the surface over which the acid drainage occurs as well as the receiving stream, further determines whether there will be an impact as well as the severity of the impact (Oliff, 1963) (Dallas & Day, 2004).

![Figure 9: a Coal mine-related pollution event (June 2007), in the Wilger River](image)

Source: McCarthy and Pretorius (2009)
According to McCarthy et al. (2009), it is believed that the blue colour is due to the precipitation of aluminium compounds in the river. McCarty et al. (2011:6), further mentions that AMD is one of the most serious environmental problems arising from coal mining, due to the generation of sulphuric acid as a result of a chemical reaction between an iron sulphide mineral (pyrite) present in the coal and its host rocks and oxygen-bearing water (infiltrated rain water). Why does this happen? According to McCarthy et al., (2009):

> Under natural conditions, the process is extremely slow and other equally slow reactions completely neutralize the acid. However, mining breaks up the rock mass allowing free access of water and the acid-producing chemical reactions proceed faster than the acid can be neutralized. The acid water dissolves aluminium and heavy metals (iron, manganese and others) and is toxic to animal and most plant life.

Figures 7 (a-c) all form part of McCarthy and Pretorius’s study, showing the effects of AMD on the environment as well as collapsing of mines and the result of decanting. Figure 9 explains the effect due to the precipitation of aluminium compounds found in the Wilger River during June 2007, which relates to the AMD.

**Effects and mitigation attempts of AMD**

> When crops are irrigated with AMD-polluted waters, the metals can be found in agricultural soils and in the roots and shoots of plants. Increased concentrations of certain metals may be phytotoxic to plants. Aluminium (Al), for example, is an important metal associated with AMD and acidification. Below a pH of 5, Al is toxic to plants and acts as an important growth-limiting factor for crops, causing cell damage and limited nutrient uptake. Hence acidification and consequent release of Al in AMD affected areas can lead to significant losses in plant biomass and crop yields (the severity depends on the kind of crop, its genotype and its tolerance levels). Aluminium toxicity in shallow soils can be countered by increasing the pH of the soil with lime treatment, and nutrient deficiencies can be addressed by applying more phosphates. Ammonium-based inorganic nitrogen fertilizers on the other hand would add to the acidification problem. However, liming and phosphate additions are only feasible for shallow-rooted crops and their expense creates a financial burden to farmers. In turn, the use of phosphates adds to the eutrophication crisis in South Africa, where currently data from 88% of the national water quality monitoring sites indicate that the waters already exceed the Resource Water Quality Objectives.
The main impacts on aquatic ecosystems (mainly Gold, Uranium and Coal mining) are therefore related to the following (Dallas & Day, 2004):

- Increased Heavy metals in Streams
- Addition of toxic and non-toxic metals
- Acid mine drainage
- Increased Suspended Solids
- Dissolved solids
- Increased hardness
- Increased sulphates
- Increased trace metal concentrations
- Decreased DO (Dissolved Oxygen)
- Decreased pH

**Mining and ground water**

The impacts of mining on ground water are still poorly understood. In most cases the effects of the act of mining on groundwater is localised to the mining area (Younger & Wolkerdorfer, 2004). This is dependent on the rehabilitation procedure of the mine (operational and closure phases), the extent to which blasting takes place, depth below the surface, geology, topography and the size of the catchment in which the mine is located. The effects of mining on groundwater adjacent to or close to a mining area are only possible if the area in question is situated downstream and in the same drainage/sub-catchment region of the mine.

Groundwater usually decants in tributaries and streams in the vicinity or area of the mine and this is determined by the geo-hydrological study. Pollution can occur both directly and indirectly. The direct effects manifest if groundwater is located down gradient from a surface mine which drains into surface pits and ponds or water that filters through to groundwater during rainfall events contaminated by surface pollutants on the mine property. Blasting may sometimes cause rock fractures to develop between two naturally divided areas creating a connections between underground seams through which polluted water can drain into adjacent unpolluted underground areas. This is an indirect manner (Rauch). Careful evaluations of the geo-hydrological study will provide a clearer understanding of the potential risks involved in groundwater contamination of areas in close vicinities of the mine. Mine closure applications and EMPR's should indicate the degree to which a mine is rehabilitated and the extent to which the contaminated groundwater is localised.
A national freshwater priority atlas was published and released during August 2011. The atlas (NFEPA) was a combined effort involving various stakeholders namely the CSIR, South African National Biodiversity Institute (SANBI), Water Research Commission, Department of Environmental Affairs, Department of Water Affairs, Worldwide Fund for Nature (WWF), South African Institute for Aquatic Biodiversity (SAIAB) and South African National Parks (SANParks) (Nel, et al., 2011). The Atlas aims at providing the first comprehensive study regarding the importance of freshwater ecosystems of South Africa and the need to maintain the areas identified as priority areas. The atlas will hopefully provide insight and knowledge into the decision making processes with regards to land use planning and sustainable development (Nel, et al., 2011).

**Current rehabilitation research**

Research on the rehabilitation of mining waste impounds have been conducted as early as the 1980’s (Wells, 1987) (Jewaskiewitz & Lombard, 1987) and probably earlier due to the heightened awareness of the effects of mining on water quality (Dallas & Day, 2004). Detailed information on remediation aspects on mines and mine seepage areas was produced in 2002 by Brown et al. Some means of rehabilitation include:

---

**Map 7: Aquatic biodiversity importance status areas**


- Chemical removal of sulphates (Dallas & Day, 2004)

- Inhibition of bacterial oxidation of pyrite for inhibiting the formation of acid drainage (Loos, Bosch, & Mare, 1990a) (Loos, Conradie, Whillier, Mare, & Bosch, 1990b) (Dallas & Day, 2004)

**The water cleaning plants of the mines**
Air pollution & the effects of coal dust

Within the pilot study area, we find the proposed Springboklaagte colliery. The proposed mine’s air pollution impact assessment was done by Airshed Planning Professionals (Pty) Ltd, a consulting company located in Midrand, South Africa, specialising in regional air pollution impacts.

The effects of air pollution are well described in their report named “Air quality impact assessment for the proposed Springboklaagte colliery, Mpumalanga”. Most of their findings were concluded based on data already available from mines in the vicinity, the impacts in the report was thus modelled from other sources, as the mine is not yet in operation. According to Grobler and Liebenberg-Enslin (2011:34) sources of atmospheric emissions at the proposed Springboklaagte Colliery and at the neighbouring collieries could include:

- fugitive dust from blasting, drilling, materials handling (overburden, interburden, waste rock, coal, discard), vehicle entrainment, wind erosion, tipping, crushing and screening;
- sulphur dioxide, nitrogen oxide and carbon monoxide emissions from blasting operations; and
- Potential sulphur dioxide and volatile organic emissions from the spontaneous combustion of discard dumps.

**Figure 10: Air pollution effects from proposed Springboklaagte colliery**
The effects of the emissions referred to above are shown in figure 4, where the PM10 refers to particulate matter with an aerodynamic diameter of \(< 10 \mu m\). This example was drawn to shown the effects of one pit in a proposed mining area. The blue area (beyond the mining boundary) is well above the limit, according to the National Ambient Air Quality Standards (NAAQS).

Their conclusions for this area, called “Block 6” are the following:

During the period July 2013 to January 2017 when Block 6 is mined the predicted daily concentrations exceed the NAAQS to all sides of the mine, including at almost all simulated sensitive receptors. The annual NAAQS is predicted to be exceeded slightly to the north and south east of the mine boundary, and the Trapvas, Kromdraai and Weltevreden sensitive receptors to the north and south east of block 6 are impacted.

So what significance does this have on the economics within the pilot area? The answer has not yet been found, as any true figures or trials with maize planting under these conditions have been recorded. Within the air assessment document of Airshed Planning Professionals (Pty) Ltd, literature reviews on plant production was recorded. Some included reports of reduction in yield, while others mentioned less pollination. All of the mentioned findings should have negative effects on maize production, i.e. it will most likely decrease the average yield.

Harmens, Mills, Hayes, Williams and De Temmerman (2005) as cited in Grobler Liebenberg-Enslin (2011:98) had the following results for particulate matter on vegetation:

Suspended particulate matter can produce a wide variety of effects on the physiology of vegetation that in many cases depend on the chemical composition of the particle. Heavy metals and other toxic particles have been shown to cause damage and death of some species as a result of both the phytotoxicity and the abrasive action during turbulent deposition (Harmens et al, 2005).

According to the authors, Harmens et al, 2005; Naidoo and Chirkoot, 2004, Hirano, Kiyota, and Aiga, 1995, Ricks and Williams, 1974 (cited in Grobler Liebenberg-Enslin, 2011:98) “Heavy loads of particle can also result in reduced light transmission to the chloroplasts and the occlusion of stomata” as well as decreasing the efficiency of gaseous exchange (Ernst, 1981) which leads to water loss.

According to Harmens et al, 2005 (in Grobler and Liebenberg-Enslin, 2011:98) these heavy particles may also disrupt some of the other physiological processes such as bud break, pollination and light absorption/reflectance. Spencer, 2001 further suggests that the chemical composition of these dust particles will have an effect on plants and have indirect effects on soil pH.

Chirkoot and Naidoo found the similar trial results, as to the authors mentioned above. Chirkoot and Naidoo’s findings were based on a study in the Richards Bay harbour, to evaluate the effects of coal dust on trees production.
The study was conducted on 10 Mangrove trees from two different plots. From their study it was evident that coal dust significantly reduced photosynthesis of upper and lower leaf surfaces. The reduced photosynthetic performance was expected to reduce growth and productivity. In addition, trees in close proximity to the coal stockpiles were in poorer health than those further away. (Naidoo & Chirkoot, 2004).

To relate this back to maize production, it is clear that reduction in production is possible, as proven by the literature from this section. In our opinion, the effects of air pollution on cash crops are summarized by the Canadian Environmental Protection Agency (CEPA) (in Grobler & Liebenberg-Enslin, 2011:98) as:

*Air pollution adversely affects plants in one of two ways. Either the quantity of output or yield is reduced or the quality of the product is lowered. The former (invisible) injury results from pollutant impacts on plant physiological or biochemical processes and can lead to significant loss of growth or yield in nutritional quality (e.g. protein content).*

**Social impacts of mining on agriculture**

Mpumalanga's growth in per capita compensation for certain skill levels, based on the two industries, agriculture and mining are compared in table 11. According to these findings, we can see that growth in per capita compensation in the two industries is very similar.

**Table 10: Growth in per capita compensation for the two industries (Mpumalanga)**

<table>
<thead>
<tr>
<th>Period 1995-2009</th>
<th>Agriculture, fishing &amp; forestry, Growth in per capita compensation</th>
<th>Mining and quarrying Growth in per capita compensation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compensation for skill level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highly-skilled</td>
<td>10.2</td>
<td>9.9</td>
</tr>
<tr>
<td>Skilled</td>
<td>7.2</td>
<td>9.9</td>
</tr>
<tr>
<td>Semi-unskilled</td>
<td>9.3</td>
<td>9.8</td>
</tr>
</tbody>
</table>

*Source: Blignaut C.S. 2012 (publication due May 2012)* from quante easy data
Table 11: Employment figures per sector (Mpumalanga)

<table>
<thead>
<tr>
<th>Employment per industry for the year:</th>
<th>Agriculture, hunting, fishery and forestry</th>
<th>Mining and quarrying</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>130 791</td>
<td>49 982</td>
</tr>
<tr>
<td>2005</td>
<td>115 914</td>
<td>38 796</td>
</tr>
<tr>
<td>2009</td>
<td>81 078</td>
<td>57 771</td>
</tr>
</tbody>
</table>

Employment per industry for the year:

<table>
<thead>
<tr>
<th>% of Agriculture, hunting, fishery and forestry in TOTAL employment</th>
<th>% of Mining and quarrying in TOTAL employment</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>17.5 %</td>
</tr>
<tr>
<td>2005</td>
<td>15.2 %</td>
</tr>
<tr>
<td>2009</td>
<td>8.7 %</td>
</tr>
</tbody>
</table>

Source: Blignaut C.S. 2012 (publication due May 2012) from quantec easy data

Agriculture’s employment rate is decreasing, whereas mining is slowly increasing in the province. But taking into consideration that agriculture is losing land (farms) to mining, this phenomenon does make sense.

Quantifying the social impact that mining has on agriculture is again a situation where the direct on-farm effects calculated are used as an example. For instance: a farmer would employ an unskilled worker, who does not necessarily have a metric certificate, but the person can read and write. He would then, at his own cost and time to develop the persons driving ability and in the end give him/her the opportunity to get their drivers licence. This person would now have a certain skill (Code 14 licence). According to the farmers interviewed, most of these workers are then “bought” by the mines. It is then rather costly and difficult to replace these drivers and start the process all over.

According to one of the farmers, Mr. Peet Bezuidenhout, a neighbour of one of the new coal mines said, “When the mine bought the farm, they promised to employ most of the farm workers, but this did not realize as most of the workers does not have a matric certificate. They ended up unemployed, with their entire families having to leave the farm.”

Potential job losses in the pilot study area

With the focus on maize production in the pilot study area, an estimated 57 523 hectares of cultivated maize fields can potentially be out of production due to current and prospecting mining activities (table 5.1 & 5.2). Using the labour multiplier of 0.01 (BFAP, 2011) for maize production, a total of 575 employees will be removed from farms, combined with their families this number could increase to 1 783 (assuming 70% are married, with 2 dependants). The contrary could also true, where mining could employ these workers, but from correspondence with neighbouring farmers, this is not necessarily the case.

An example on a typical 1000 ha farm losing 400ha due to mining related activities, would be 0.01*400 = 4 workers that would need to be either retrenched or the farmers would keep them at an extra cost to their business.

Health risks associated with coal mining
Knowing that not all the land will be bought by the mines, the health risks are increasing for the remaining farm, rural village and town inhabitants in the Highveld. The findings from the WWF-SA, (2011:58) showed that AMD drainage continues being the main risk of pollution, and it remains uneconomic to try and mitigate the effects. Human exposure to AMD pollutants can occur through ingestion of contaminated water, food or through dermal absorption via water or air. According to Coetzee, L., Du Preez, H.H. and Van Vuuren, J.H.J., (in WWF-SA, 2011:58):

Metals such as aluminium, copper, zinc and arsenic (all related to AMD effects) can concentrate in plant tissue when plants are exposed to elevated concentrations of these metals in the vicinity of mining activities106. If such plants are consumed by animals and humans, the metal concentrations may be carried along in the food chain. Animals that drink contaminated water and/or feed on contaminated plants have been shown to accumulate metals in their tissue or in their milk.

The effects of mining on the local coal mining communities are also sometimes overlooked, the social labour plan would always say how they will build houses and provide water, but according to the West Virginia University Health Sciences Center, 2008 as cited in WWF-SA (2011:58):

Studies have looked at health effects in coal mining communities and found that community members have a 70% greater risk of developing kidney disease and a 64% greater risk of developing chronic obstructive pulmonary disease (COPD) such as emphysema. They are also 30% more likely to report high blood pressure (hypertension).

Again agriculture is left with the turmoil created by the external effects of mining, as the rehabilitated land will most probably be affected by AMD (as this study have shown) and the community living on this land will have to bring in fresh water from somewhere else to make a living. As AMD is clearly a toxic reality for the post-mining inhabitants and to the remainder of the current farmers living in the area.
Economic impact, rehabilitation and the way forward. (Conclusion)

Included in Mpumalanga’s GVA (Gross Value Added) calculations is the mining sector, which also contributes towards other factors such as employment and social empowerment. But the competition for land still exists between the two sectors as agriculture’s cash crop productions sustainability is at threat due to the demand in coal. GVA is not the only trade-off between the two industries, as the agricultural sector is in need of electricity, so is the entire country, i.e. coal production is necessary, but then at what cost towards the environment, food security and social sustainability. The average GVA for the mining sector in the period 1996-2010 was 21.9%, whereas agriculture’s average GVA for the same period was 3.8% (quantec easy data, 2011). When the mines are gone, their contribution to the total GVA would have left with them, but agriculture on the other hand has remained for hundreds of years.

So the question then, do we sacrifice high potential arable land combined with sustainable agriculture (hence stable GVA) and food security, for “rehabilitated” low potential land with the costs of pollution that cannot yet be quantified, as future generations will pay the full price of it.

Within the context of this pilot study report, a few economic conclusions could be drawn, based on the literature of others and some of BFAPs owns calculation. To put an exact figure on the effects that mining will have on agricultural production is not possible at the moment, as the externalities are immense. These externalities include: Water pollution, soil degradation, air pollution and the costs associated at trying to reverse these effects. What we do know is that we are currently trading high potential arable soils for mining low quality coal, at the cost of exhausting South Africa’s “compost heap” in terms of fertile soils.

Table 12: Overview of economic impacts in the study area

<table>
<thead>
<tr>
<th>Year</th>
<th>Safex (BFAP model)</th>
<th>Tonnage per Ha</th>
<th>Average input costs</th>
<th>Maize net revenue (A)</th>
<th>400ha maize - Revenue (A) * 400</th>
<th>6% interest in bank on previous year’s total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>R 2 000</td>
<td>7.6</td>
<td>R 8 000</td>
<td>R 7 200</td>
<td>R 2 880 000</td>
<td>R 172 800</td>
</tr>
<tr>
<td>2013</td>
<td>R 1 773</td>
<td>7.8</td>
<td>R 8 560</td>
<td>R 5 184</td>
<td>R 2 073 771</td>
<td>R 307 594</td>
</tr>
<tr>
<td>2014</td>
<td>R 1 841</td>
<td>7.9</td>
<td>R 9 159</td>
<td>R 5 395</td>
<td>R 2 157 955</td>
<td>R 445 159</td>
</tr>
<tr>
<td>2015</td>
<td>R 1 923</td>
<td>8.1</td>
<td>R 9 800</td>
<td>R 5 711</td>
<td>R 2 284 457</td>
<td>R 445 159</td>
</tr>
<tr>
<td>2016</td>
<td>R 2 245</td>
<td>8.2</td>
<td>R 10 486</td>
<td>R 7 986</td>
<td>R 3 194 287</td>
<td>R 590 481</td>
</tr>
<tr>
<td>2017</td>
<td>R 2 031</td>
<td>8.4</td>
<td>R 11 220</td>
<td>R 5 822</td>
<td>R 2 328 738</td>
<td>R 790 857</td>
</tr>
<tr>
<td>2018</td>
<td>R 2 310</td>
<td>8.6</td>
<td>R 12 006</td>
<td>R 7 765</td>
<td>R 3 105 882</td>
<td>R 942 604</td>
</tr>
<tr>
<td>2019</td>
<td>R 2 250</td>
<td>8.7</td>
<td>R 12 846</td>
<td>R 6 796</td>
<td>R 2 718 228</td>
<td>R 1 138 062</td>
</tr>
<tr>
<td>2020</td>
<td>R 2 329</td>
<td>8.9</td>
<td>R 13 745</td>
<td>R 6 997</td>
<td>R 2 798 655</td>
<td>R 1 312 883</td>
</tr>
<tr>
<td>2021</td>
<td>R 2 350</td>
<td>9.1</td>
<td>R 14 708</td>
<td>R 6 637</td>
<td>R 2 654 672</td>
<td>R 1 491 291</td>
</tr>
<tr>
<td>2022</td>
<td>R 2 421</td>
<td>9.3</td>
<td>R 15 737</td>
<td>R 6 692</td>
<td>R 2 676 720</td>
<td>R 1 661 276</td>
</tr>
</tbody>
</table>

Source: Own calculations
Table 13: “Keep farming” scenario

<table>
<thead>
<tr>
<th>SCENARIO 1 - Keep Farming</th>
<th>E.g 7200*400=</th>
</tr>
</thead>
<tbody>
<tr>
<td>400ha maize - Revenue (A) * 400</td>
<td>2880000</td>
</tr>
<tr>
<td>Total over 10 years</td>
<td>R 28 873 364</td>
</tr>
<tr>
<td>Accumelated interest over 10 years (6%)</td>
<td>R 8 853 007</td>
</tr>
<tr>
<td>Sum total income</td>
<td>R 37 726 371</td>
</tr>
<tr>
<td>Sum total / 400ha: Income per ha over 10 years</td>
<td>R 94 316</td>
</tr>
</tbody>
</table>

Source: Own calculations

Table 14: “Sell land” scenario

<table>
<thead>
<tr>
<th>SCENARIO 2 - Sell land</th>
</tr>
</thead>
<tbody>
<tr>
<td>If the land is sold for R 30 000/ha (current average selling price)</td>
</tr>
<tr>
<td>with 10% interest, in 10 years (if e.g. Invested)</td>
</tr>
<tr>
<td>per ha income over 10 years</td>
</tr>
</tbody>
</table>

*Relating to "keep farming income" asking price for 400ha | R 14 545 149

*Therefore comparing to "keep farming" real asking price could be (R/ha) – with very conservative calculations | R 36 362 |

Source: Own calculations

Due to all the externalities mentioned in this report, one can argue that the “real price” of land could be even greater than the table 14 example, given that the effect of losing “X” hectares from an economic farming unit would have vast downstream multiplier effect. Also the lifetime of the farmer on the farm is known to be for generations. The R 36 362/ha could then be made back within 5years, from maize production.

The Highveld (and the entire Mpumalanga) is expected to receive increased levels of precipitation, according to the CSIR (in Blignaut C.S., 2012:176) as well as an increase in heat units. The yields in maize are then expected to increase even more with improved technology, rotational cropping with soybeans, improved cultivation practises and then the increased precipitation and heat units. The potential rather exists to have surplus production in maize, soybeans and sugarcane, all which are replacement sources to create bio-fuels. Using these crops as a long-term sustainable source of energy production vs. Medium term ecological unsustainable coal production should be investigated, Blignaut (2012:174).
Sustainability of rehabilitation

The rehabilitated land is not economically sustainable....

Potential further studies should involve

- Coal as a source of power vs. Biofuels/renewable energy


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Steenekamp P.I. 2011. Soil, land capability and land use assessment of Shanduka Coal’s proposed Springboklaagte Mine, situated on portions 1, 11, 12, 13 and 14 of the farm Kromdraai 263 IR, portions 2, 4, 5 and 9 of the farm Springboklaagte 306 IR and portions 1, 2, 10, 11, 14, 19, 20, 21 and 22 of the farm Weltevreden 307 IR near Delmas, Mpumalanga.


Appendix A
Concerns further downstream

Figure 11: Upper Olifants testing stations
Source: CSIR 2011

The fact remains that some 74% of coal mined is used locally to provide energy to all the sectors, but is the true economic cost calculated for the other 26%(high grade) coal that gets exported? As the saying goes “South Africa exports the best, and burn the rest”. Serious considerations for alternative energy is needed, as food security for the country is at stake, and not just that, but agricultures GDP contribution as well. Taken that the “downstream” effects of these mines can potentially affect the two largest irrigation schemes in South Africa, since it was made known to us, that the effects of contaminated water is felt at Groblersdal and Marbalhall as it should be noted that some 52% of South Africas Citrus is produced in Mpumalanga 21 and Limpopo31.
Table 1 shows Mpumalanga’s average growth rate for the two industries, based on 2005 prices Blignaut C.S. (2012:108).

<table>
<thead>
<tr>
<th>Period</th>
<th>Agriculture, fishery and forestry</th>
<th>Mining and quarrying</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996-2000</td>
<td>4.4%</td>
<td>2.2%</td>
</tr>
<tr>
<td>2001-2005</td>
<td>2.7%</td>
<td>2.0%</td>
</tr>
<tr>
<td>2006-2010</td>
<td>5.6%</td>
<td>-1.4%</td>
</tr>
<tr>
<td>1996-2010</td>
<td>1.2%</td>
<td>0.9%</td>
</tr>
</tbody>
</table>

Source: Blignaut C.S., 2012

The upper Vaal River catchment is relatively un-impacted by mining, but *if all the applications for mining permits in this catchment are granted, it is likely that the Vaal River will suffer a similar fate to rivers in the Witbank area, creating serious water supply problems for the industrial heartland of the country.*

![Figure: Upper Vaal new prospecting applications. Extent of mining, prospecting and exploration rights in Mpumalanga (2005 – 2010 orange) and post 2010 applications (yellow).](source)

Source: WWF 2011:58
References for appendix:
