AIR QUALITY

Mashala Resources – Proposed de Wittekrans Coal Mine

Directives amendment

Air Quality report

Issue/revision	Final
Job number	09-038
Date	August 2010
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1. INTRODUCTION

SDG Consulting was approached by Groundwater Consulting Services (GCS) to provide specialist air quality input into the scoping and environmental impact studies to assess the potential impact that the proposed Mashala Resources de Wittekrans coal mine is likely to have on the surrounding environment. A report was submitted in June of 2009 and was returned after comment with further issues that needed to be addressed.

2. PROCESS DESCRIPTION

The de Wittekrans site is situated on portions of the farms de Wittekrans 218 IS, Tweefontein 203 IS, Groblershoek 191 IS, Groblershoop 192 IS and Israel 207 IS, located on the Mpumalanga highveld, to the southeast of Hendrina.

The proposal is for three opencast coal mine portions and underground mining complete with associated infrastructure. Emissions to air from a facility such as this have the potential to be significant if appropriate mitigation and management measures are not undertaken. Under normal, responsible operation, a number of areas of potential emissions are readily identified:

- Dust and associated emissions during building, operational and decommissioning phases;
- Dust emissions during operation, particularly associated with loading and offloading of material, dumping of overburden and waste rock, and the transport of the coal either via truck or conveyor;
- Fugitive dust emissions associated with the wind entrainment of large areas of exposed earth, dumped material and coal that will be created during the project and;
- Vehicle emissions associated wit the building, operation and decommissioning phases.

It should also be noted that, as with any coal mining operation, the potential for fire exists which could lead to long term, sustained and significant impacts on the surrounding air quality.

3. AREA DESCRIPTION

3.1 Legislative framework

The project is situated on the Mpumalanga Highveld, an area which has been formally declared as an air quality priority area in terms of Section 18(1) of the National Environmental Management: Air Quality Act 2004 (Act No. 39 of 2004) (AQA), to be known as the "the Highveld Priority Area" (Notice No. 1123 of 23 November 2007 contained in *Government Gazette* No. 30518).

This declaration is in recognition of the extremely stressed nature of the airshed in this region, home as it is, to much of South Africa's coal mining activity and to many coal fired power stations. While the declaration of this hotspot does not have a direct impact on the project, it will mean that in the long term this mine will operate in a legislative environment where proper air quality management will be considered a priority and appropriate management and mitigation measures against excessive emissions will be required in keeping with the broader air quality management plan for the area.

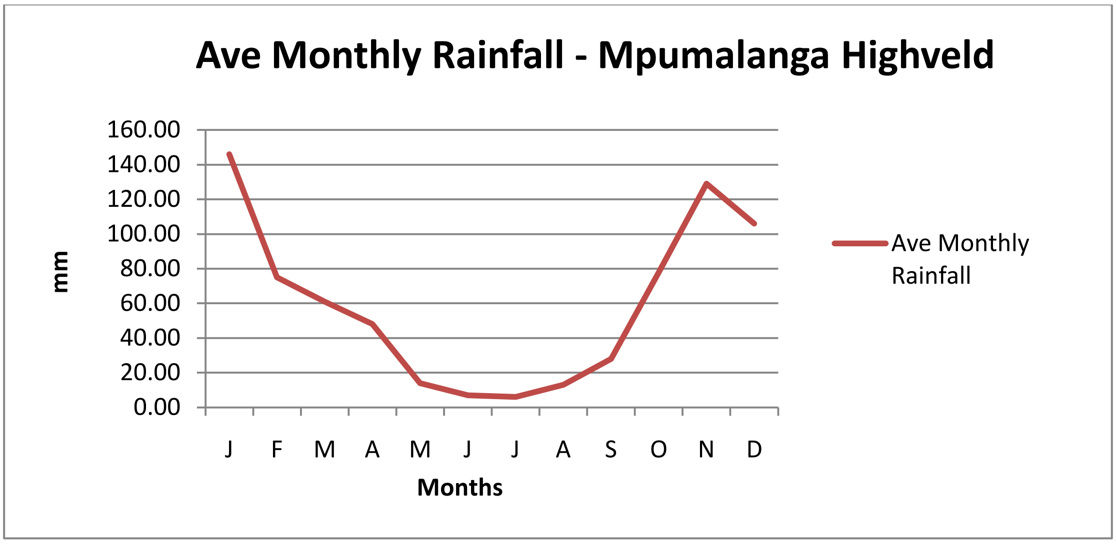
In addition, the air quality officer in charge of this plan may require access to any air quality data or modeling output associated with the mine's operations in order to formulate and properly implement this broader plan. It is imperative, therefore, that an appropriate person within the mine's staff be tasked with the establishment of sound record keeping procedures to accompany any air quality monitoring that may take place on site in the future.

3.2 Climate description and qualitative baseline assessment

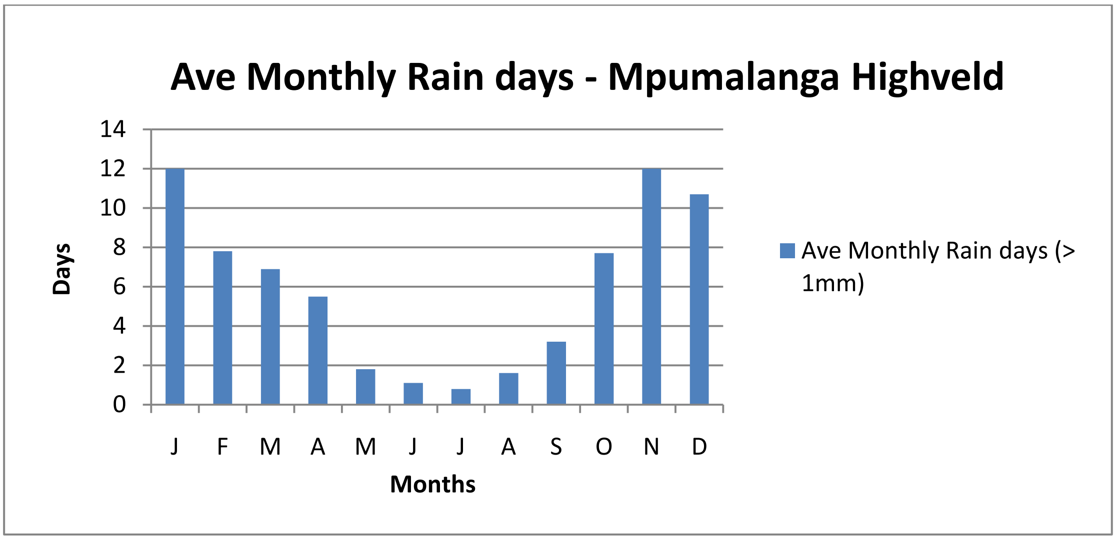
No long term weather dataset was available for the site in question so Ermelo was selected as an acceptable proxy.

Dust emissions are a function of the constitution of the exposed material (particularly silt and small particle content), wind and moisture. Conditions of fine, dry, exposed material in windy weather will result in the greatest emissions. Thus, in analysing potential dust from a source such as the de Wittekrans mine, it is these factors on which the focus lies.

3.2.1 Precipitation

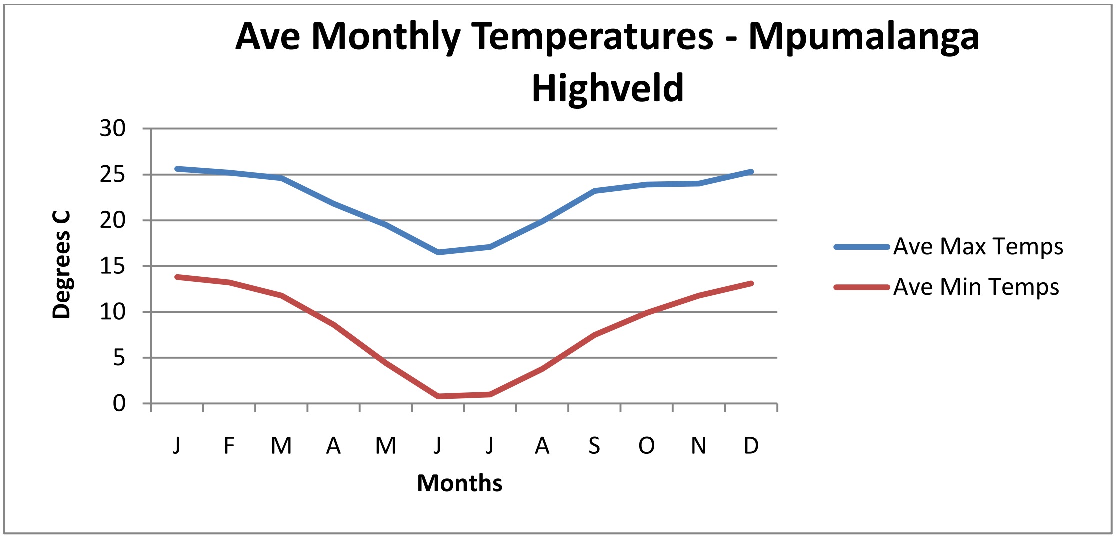


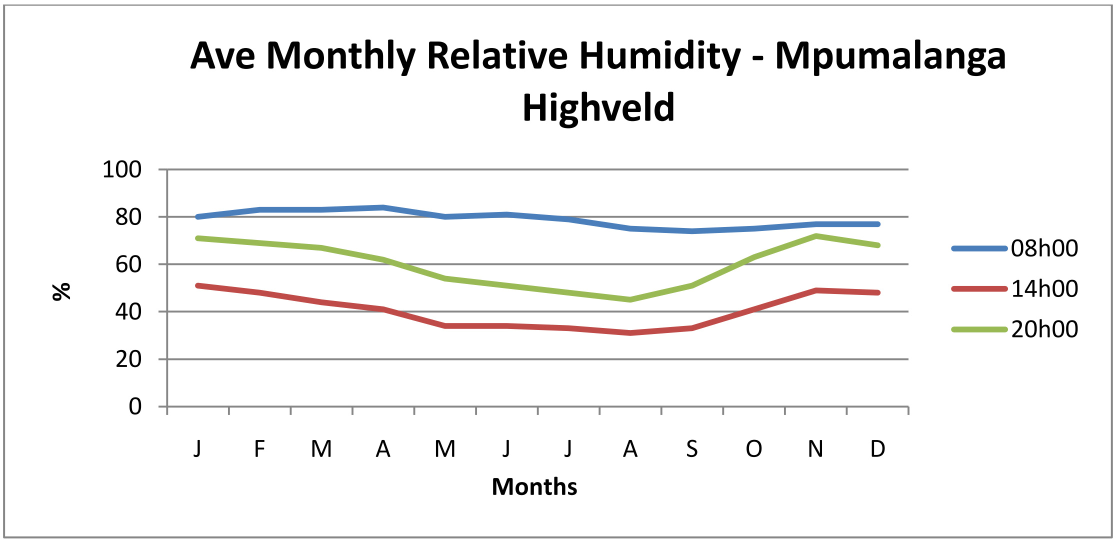
The mine is set on the Mpumalanga Highveld, at an altitude of approximately 1650m above sea level. It is in South Africa's summer rainfall region with an annual average rainfall of 711mm per year. Rain peaks early in the season, in November, and then again in January while the winter months are characterized by a long and very dry period.



Even the addition of a small amount of moisture can have a dramatic effect on the reduction of potential dust emissions. Similarly, a long spell without rain will necessitate intervention in the form of dust control measures in order to manage impacts on the surrounding environment. These will be particularly necessary during the months from April to October.

3.2.2 Temperature and relative humidity





The warmest period is December / January, when maximum temperatures average above 25 degrees centigrade while June is the coldest with daytime temperatures averaging 16.5 degrees and overnight temperatures frequently dropping below freezing. The winter period is also very dry with little or no rainfall and relative humidity dropping below the 40% mark.

3.2.3 <u>Wind</u>

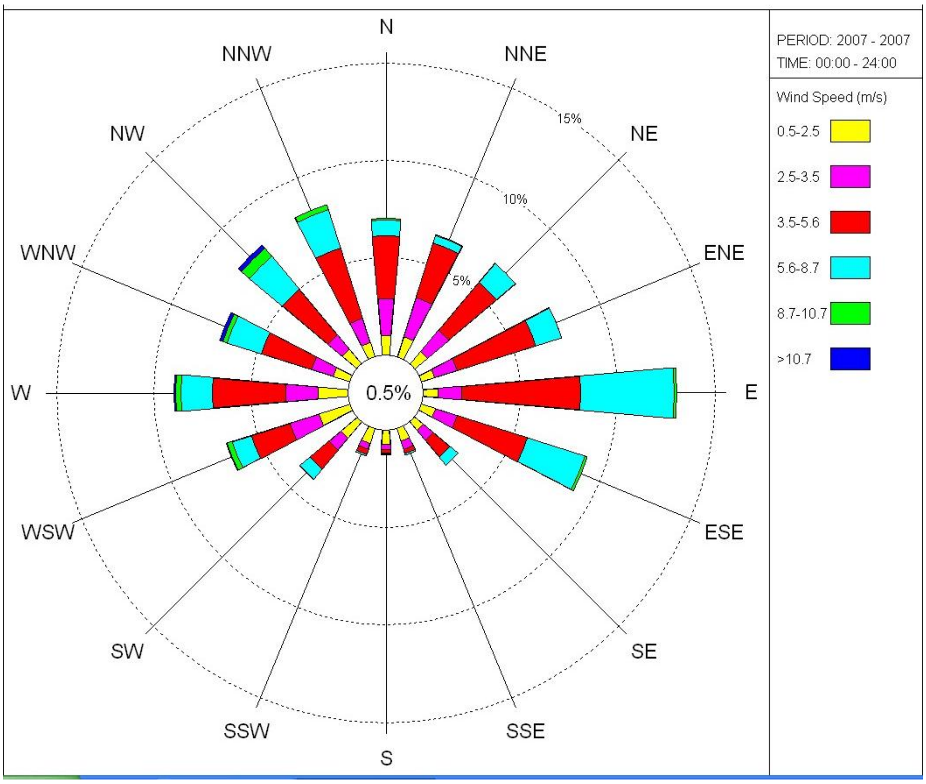


Figure 1 Annual average wind speed and direction - Ermelo, Mpumalanga (SAWS, 1990 - 2007)

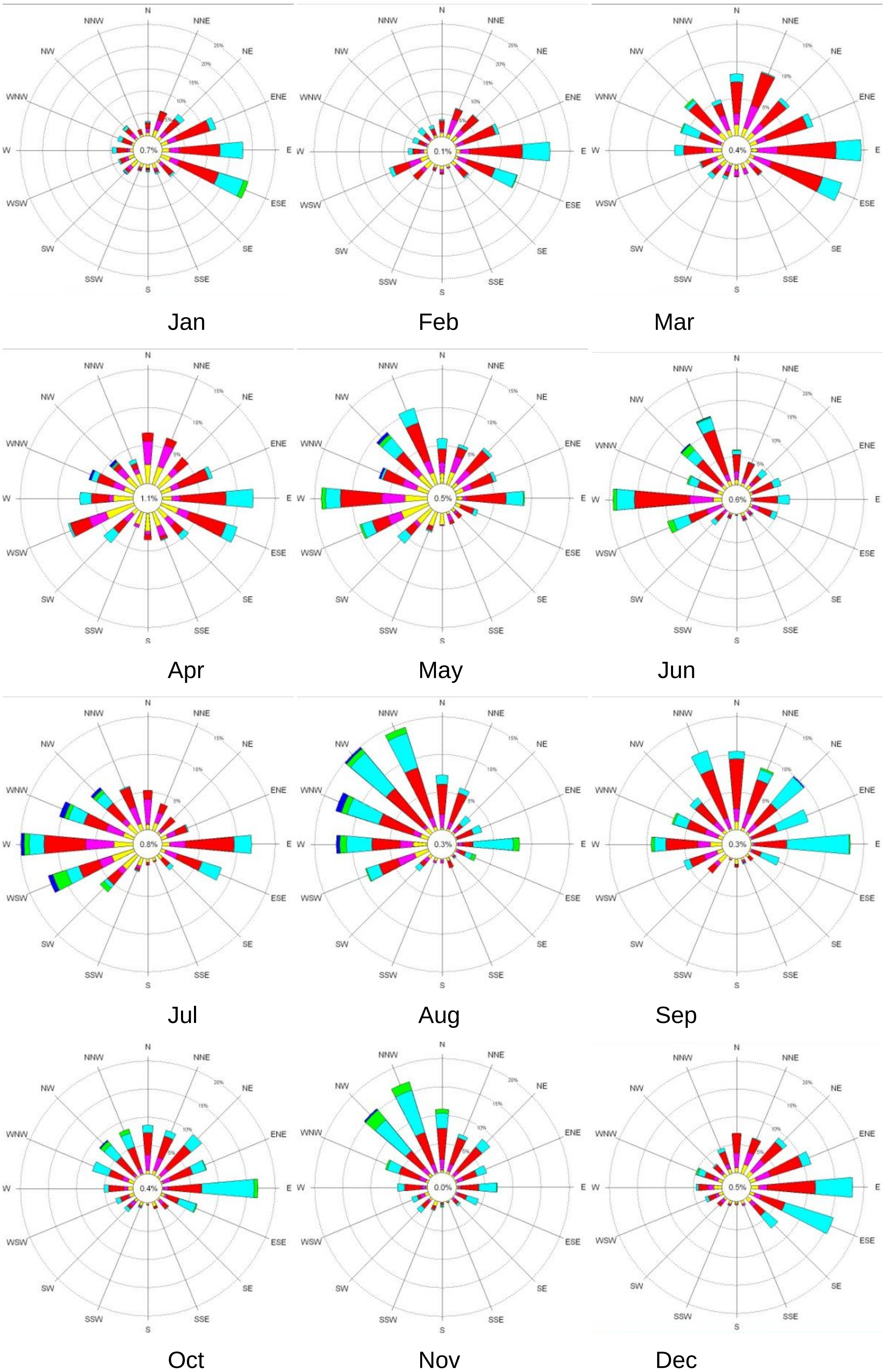


Figure 2 Monthly average wind speed and direction - Ermelo, Mpumalanga (SAWS, 1990 - 2007)

Winds are predominantly easterly with a strengthening westerly component in the winter. Strongest wind speeds are recorded in late winter, during the period July / August. More than half the data shows periods of calm (wind <0.5 $m.s^{-1}$).

The site is fairly isolated and it is unlikely that any adjacent residential areas will be affected by windblown dust. Receptor areas are agricultural and some impacts on crops could result if mitigation is not undertaken.

3.2.4 Summary

The site is in a high altitude region characterized by regular summer rains but where the winters are cool, dry and windy, resulting in conditions ideal for the desiccation of the environment and the wind entrainment of any loose material. Areas most affected by dust from the mine will generally lie to the west and northwest of the mine when synoptic level flow dominates while local meteorological conditions appear to favour dispersion to the south.

4. METHODOLOGY

Emissions to air during the extension and operation of a mine of this nature are generally limited to dust, smoke emissions from heavy machinery and vehicles, and a wide range of trace gases given off during the drying of solvents and similar processes resulting from activities associated with routine construction and maintenance. Of these, dust is by far the greatest potential polluter. The degree to which dust becomes a polluter is in direct relation to four factors:

- The nature of the area to be exposed by surface clearing (including total area, shape relative to prevailing winds and height of dumps etc).
- The moisture content of the soil and by association, the average rainfall for the area
- The silt content and grading of the material exposed to the surface
- Activities taking place on that surface (transport, loading, blasting and entrainment by the passage of vehicles)

An opencast mine results in a significant total area of previously protected material becoming exposed to the elements. Depending on the silt content and grading of the various layers of material and on the efficacy of mitigation measures in place, significant dust emissions could result.

4.1 Dispersion Modelling

Potential emission modelling is undertaken using Cambridge Environmental Research Consultants (CERC)'s latest generation model, the Atmospheric Dispersion Modelling System (ADMS 4). Input data is a combination of field data and estimates generated using the Australian National Pollution Inventory (NPI) *Emission Estimation Technique Manual for Mining, Version 2.3*. Meteorological data is sourced from the South African Weather Services (SAWS).

4.1.1 Meteorological data

Following discussions with SAWS, the nearest available hourly sequential dataset was identified as being that of Ermelo for the year 2007. This is considered to be a reasonable proxy for the region's climate.

4.1.2 Pollutants

Pollutants to air from an open cast mine under normal operations, such as is proposed are likely to fall into two main categories:

- Dust
- Fuel emissions

Fuel emissions are seldom a significant contributor to ambient, fence line pollution levels and were not considered during this study.

4.1.2.1 Dust

Dust is considered in two broad categories, namely total suspended particulates (TSP) and particulate matter with a diameter less than 10µm (PM_{10}).

TSP is also referred to as 'nuisance dust' and accounts for the visible dust that may settle and cause the clogging of machinery as well as having an adverse affect on local flora through the clogging of stomata. Due to the wide range of particles that make up TSP, modelling of this material is considered impractical. Rather, PM_{10} dispersion is modelled and the flow fields derived from that run are used as indicators of potential problem areas for TSP deposition.

The second category of dust is made up of those particles smaller than 10µm (PM_{10}). PM_{10} particles are small enough to be inhaled and are thus a significant contributing factor to respirable illness associated with air pollution.

4.1.3 Emission factors

Fugitive dust emissions from a mine of this nature are generally a function of the rate of activity on the mine and the silt and moisture content of the material being handled. These are then exacerbated by wind and dry weather conditions.

When modelling emissions from a site where real data is not available, it is possible to estimate the emissions that will be generated by using a series of equations to determine the likely emission of each process. These are called emission factors. An emission factor is a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant.

The emission factors used for this study were taken from the Australian National Pollution Inventory (NPI)'s *Emission Estimation Technique Manual for Mining, Version 2.3* (2001). The emission factors contained therein are mostly based on those developed by the United States Environmental Protection Agency (USEPA, 1985 and 1998) and are in turn published in *Emission Factor Documentation for AP-42* itself considered an industry standard. South Africa has yet to develop its own set of emission factors.

A broad overview of potential dust emissions likely to be emitted *during operation* can be obtained through the use of the NPI's general equation:

$$E_{kpy,i} = [A * OpHrs] * EF_i * [1 - (CE_i/100)]$$

where:

Ekpy,i = emission rate of pollutant i, kg/yr

A = activity rate, t/h

OpHrs = operating hours, h/yr

EF_i = uncontrolled emission factor of pollutant i, kg/t

CE_i = overall control efficiency for pollutant i, %

Thus, the following emissions of TSP and PM_{10} can be anticipated:

Table 1: Estimated emissions per activity, as per *Emission Estimation Technique Manual for Mining, Version 2.3* (2001)

Operation / Activity	TSP (g/s)		PM_{10} (g/s)	
	Estimate	Default	Estimate	Default
Excavators/shovels/front end loaders (on coal)	0.104	0.113	0.006	0.133
Bulldozers on coal	3.01	2.833	1.2	0.903
Trucks (dumping coal)	-	0.039	-	0.016
Drilling	-	0.001	-	0.000
Blasting	0.014	-	0.007	-
Wheel generated dust from unpaved roads	1.332	0.898	0.387	0.222
Scrapers	0.028	0.001	0.01	0.012
Graders	0.141		0.031	-
Loading stockpiles	-	0.016	-	0.007
Uploading from stockpiles	-	0.117	-	0.051
Wind erosion	-	0.056	-	0.028

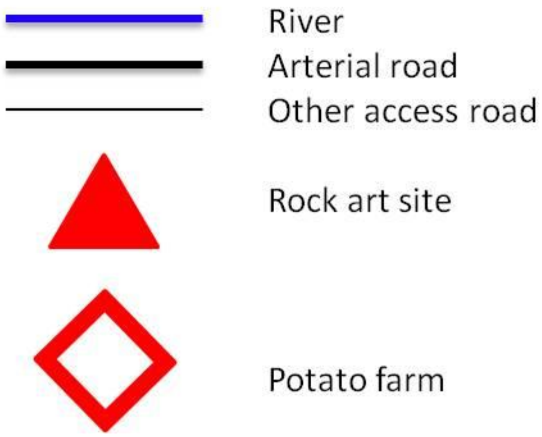
The equations used are provided to estimate dust. When any doubt existed as to the input data required, inputs were assumed conservatively, so as to maximise indicated emissions.

No background data is available so existing ambient dust was not considered. This has the effect of underestimating the effect of the facility on surrounding areas.

4.2 Results

One set of modelling runs were undertaken.

For all of the following plots, the key below applies:



The following model outputs were achieved:

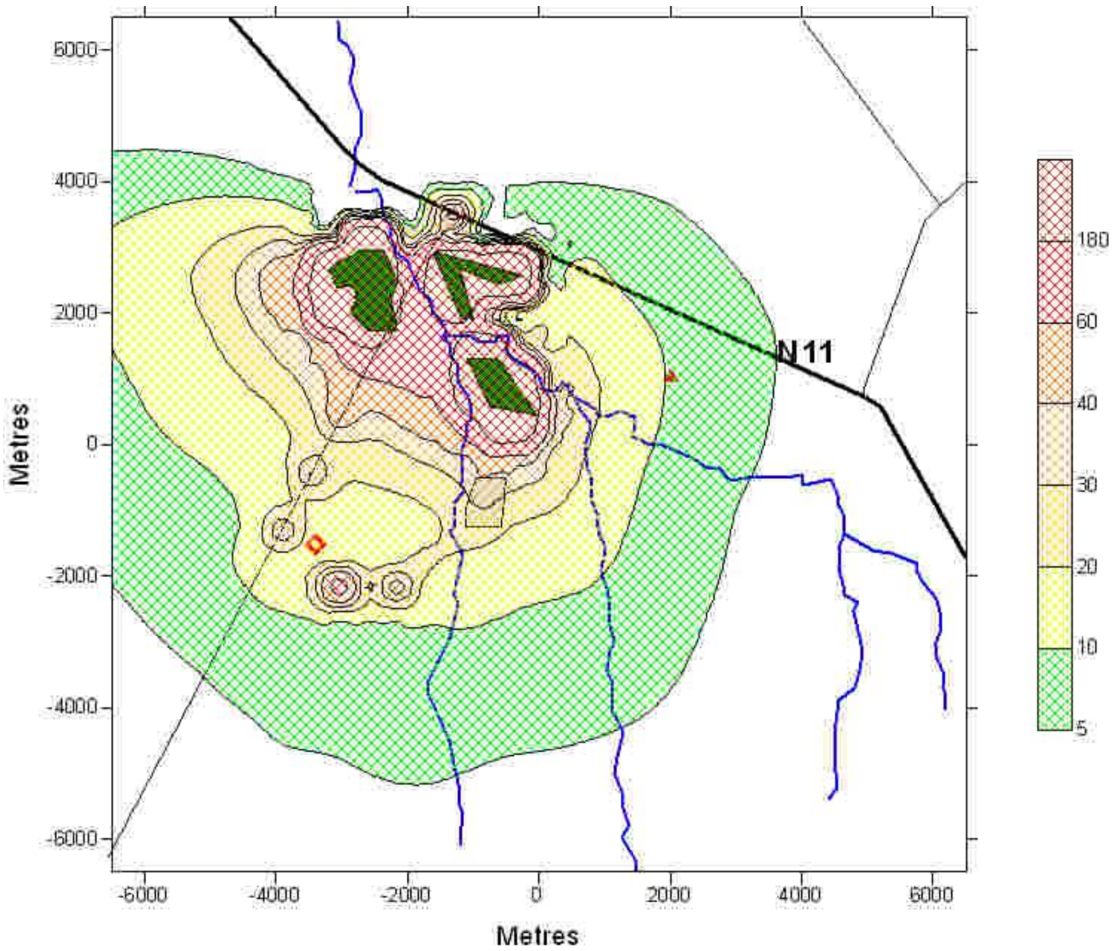


Figure 3: Modelled representation of PM_{10} dispersion from the proposed de Wittekrans coal mine. Long term averages, 24 hour averaging period, levels indicated in μg/m^3

The representation above indicates that dispersion from the proposed mine is likely to be in a predominantly westerly to south westerly direction with relatively low levels of PM_{10} material likely beyond the mine's immediate boundaries. Ambient dust is concentrated where active mining is taking place (in and around the opencast areas). The modelled levels are generally below South Africa's 24 hour average ambient guidelines (180μg/m^3) although areas within the pit associated with certain activities (particular dozers) may exceed this level if sufficient mitigation is not in place. It should be noted that peak dust levels in proximity to haul roads and active heavy machinery may sporadically exceed these levels on a shorter time scale.

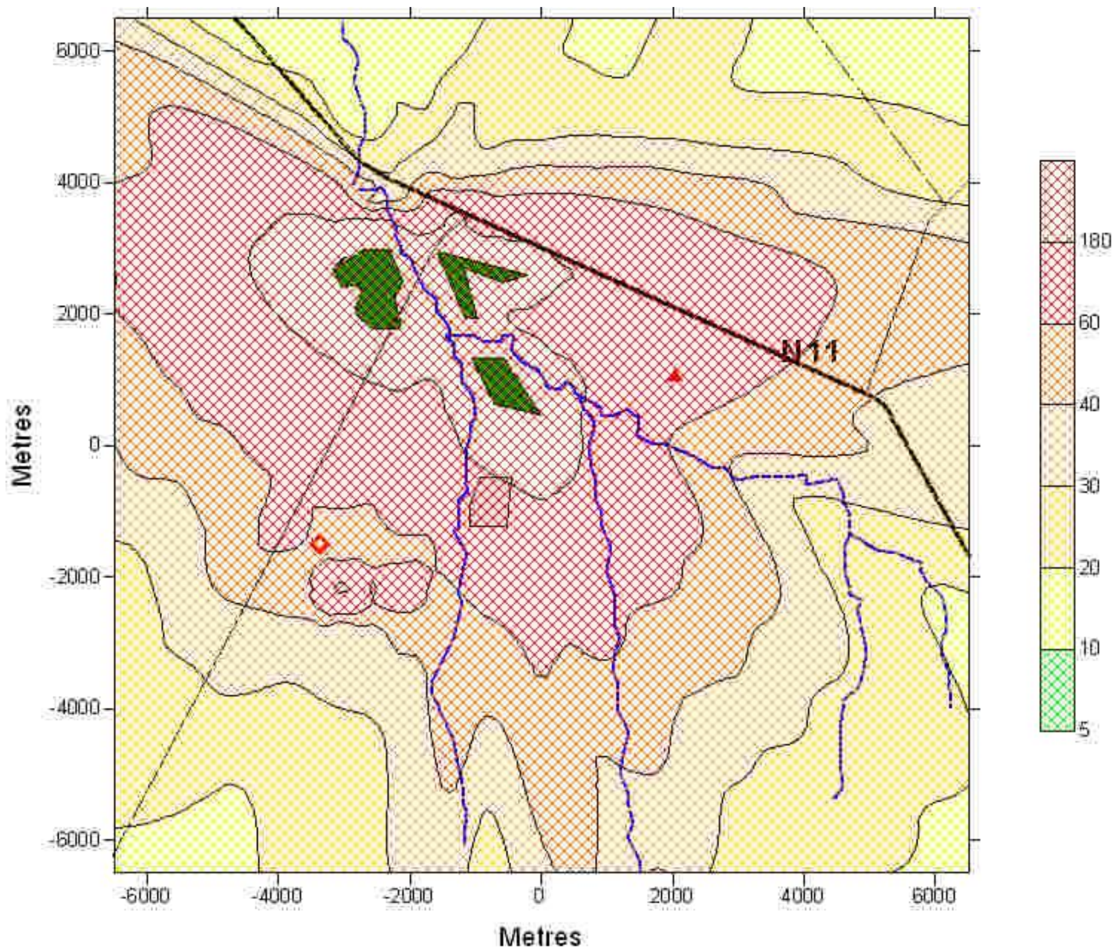


Figure 4: Modelled representation of 'worst hour' PM_{10} dispersion from the proposed de Wittekrans coal mine. Long term averages, 24 hour averaging period, levels indicated in µg/m^3

Figure 4 shows a plot of the worst hour for each grid point of the 8640 hours that make up the year long model run. From this it can be recognised that occasional exceedence of the 180 µg/m^3 is likely throughout the project area.

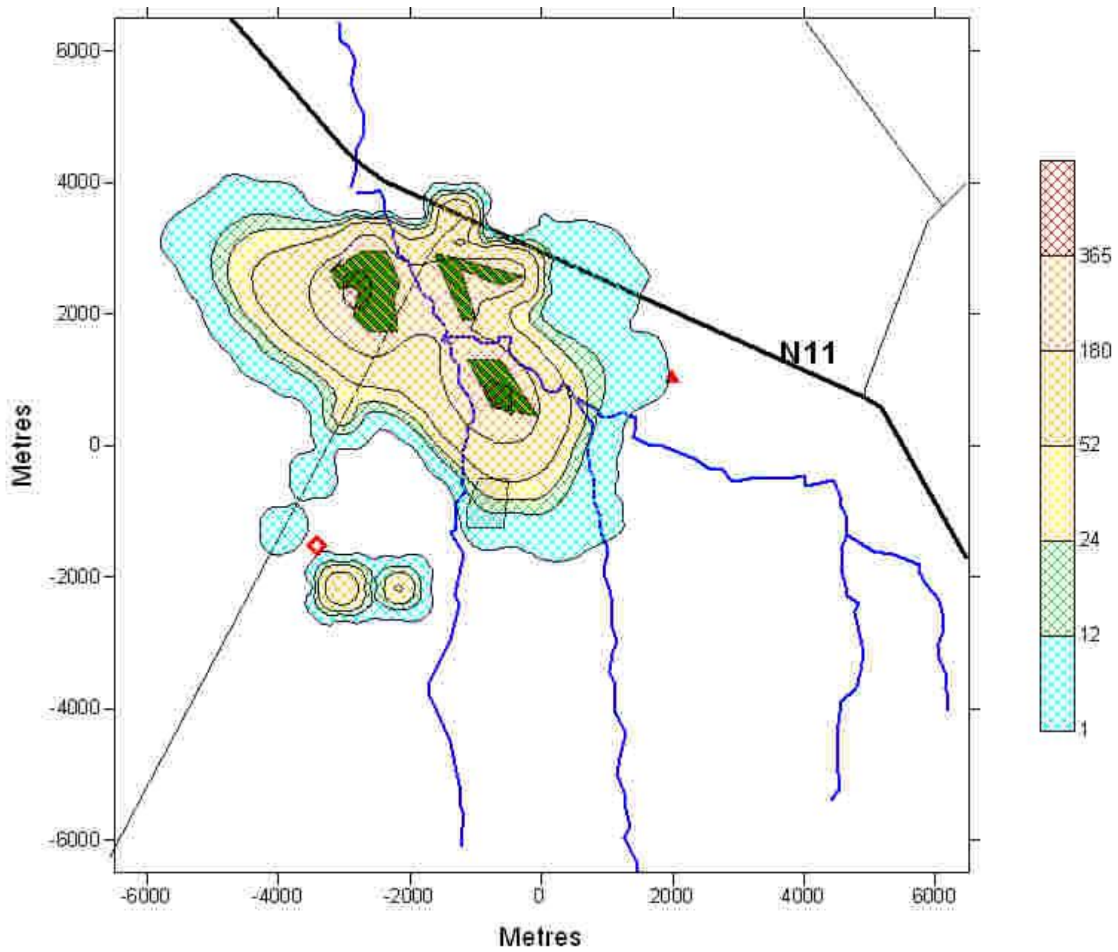


Figure 5: Modelled representation of incidences of ambient PM_{10} levels from the proposed de Wittekrans coal mine exceeding the 90 µg/m^3 level.

Figure 5 shows the likely number of exceedences of the 90 µg/m^3 level in any one year. Areas away from the mined areas are unlikely to exceed these levels. The 180 µg/m^3 level is recommended as the legal ambient dust limit. The 90 µg/m^3 level is modelled to allow for existing dust in the air to be taken into account. This plot serves to stress the importance of ensuring that appropriate mitigation remains in place in the pit and on the roads leading to the plant area at all times.

Modelling is by its nature an imperfect science and so the above results should not be read as definitively quantitative but rather should give an opportunity to assess the likely areas of high dust levels on the proposed mine. The actual levels that that dust may achieve is impossible to quantify accurately (and are probably under represented here) so every effort to mitigate emissions should be undertaken.

5. POTENTIAL IMPACTS AND MITIGATION

Emissions to air from a facility such as this have the potential to be significant if appropriate mitigation and management measures are not undertaken. Under normal, responsible operation, a number of areas of potential emissions are readily identified:

- Dust and associated emissions during building and decommissioning phases, particularly associated with blasting, loading and offloading of material, dumping of overburden and waste rock, and the transport of the coal via truck or conveyor, as well as bulldozer activity on either coal or overburden.
- Fugitive dust emissions associated with the wind entrainment of large areas of exposed earth, dumped material and coal that will be created during the project.
- Vehicle emissions associated with the building, operation and decommissioning phases.

It should also be noted that, as with any coal mining operation, the potential for fire exists which could lead to long term, sustained and significant impacts on the surrounding air quality.

5.1 Dust emissions

The modelled data indicates that a moderate increase in ambient dust levels in surrounding areas could result from the operation of this facility. Due to the inherent limitations in dust emission modelling and the extremely stressed nature of this airshed it is recommended that every effort be made to limit dust emissions from the active mine areas. In addition, the high ambient levels (>180µg/m^3) indicated in the active areas of the pit may translate into unacceptably high levels of airborne dust in the immediate vicinity of the mining machinery.

5.1.1 Dust mitigation

A dust management plan that includes some or all of the following mitigation measures is recommended (after Holmes Air Sciences (1998)):

Table 2: Estimated Control Factors for Various Mining Operations

Activity	Control	Emission reduction
Scrapers on topsoil	Artificial or natural moistening of soil	50%
Dozers on coal or other material	No control	
Drilling	Fabric filters	99%
	Water sprays	70%
Blasting coal or overburden	No control	
Loading trucks	No control	
Hauling	Watering (2 litres/m^2/h)	50%
	Watering (> 2 litres/m^2/h)	75%
	Limiting vehicle speed	(see below)
Unloading trucks	Water sprays	70%
Loading stockpiles	Water sprays	50%
	Variable height stacker	25%
	Telescopic chute with water sprays	75%
	Total enclosure	99%
Unloading from stockpiles	Water sprays	50%
Miscellaneous transfer and conveying	Water sprays with chemicals	90%
	Enclosure	70%
	Enclosure and use of fabric filters	99%

With respect to haul road dust levels, it is recommended to limit vehicle speeds, especially during high risk periods of high winds, high temperature and low humidity. On its own, the passage of a single vehicle causes a spike in pollution, dependent on speed, which returns to ambient air conditions fairly rapidly. However, under high risk conditions with multiple vehicle passes in a short space of time, entrainment into the air stream will occur, contributing to the regional dust risk. It is important to note that for speeds between zero and 40km / hour, the increase in haul road dust emission is exponential. It is impossible to monitor dust quantitatively in real time, so the following subjective classification of haul road dust defect becomes useful in alerting operators to real time conditions.

Table 3: Classification of Haul Road Dust Defect.

Dust defect degree descriptions for PM_{10} dust emissions per haul truck pass at 40km /hour ($mg.m^{-3}$)				
Degree 1 <3.50	Degree 2 3.51 to 23.50	Degree 3 23.51 to 45.00	Degree 4 45.01 to 57.50	Degree 5 >57.51
Minimal dust	Dust just visible behind vehicle	Dust visible, no oncoming vehicle driver discomfort, good visibility	Notable amount of dust, windows closed in oncoming vehicle, visibility just acceptable, overtaking difficult	Significant amount of dust, windows closed in oncoming vehicle, visibility poor and hazardous, overtaking not possible.

Overloaded trucks spilling coal can result in a layer of finely ground coal forming over the road surface. This can result in pervasive dust problems as the fine coal dust is entrained by the passing trucks. Normally, this dust would settle within the confines of the mine area but because of the unusual placement of this haul/access road, a very real threat of dust impacting on the neighbouring areas exists. It is recommended that strict maximum loads be applied to the trucks to minimise the likelihood of spillage.

Following concerns from the Department of Mineral Resources (DMR) regarding the amount of water that would be required to sufficiently suppress road entrained dust, it is recommended that dust retardant chemicals be sprayed on all exposed areas where haul trucks are operating.

5.2 Fugitive dust emissions

The most significant period for wind entrainment of loose material is likely to be during the dry winter months. In addition, material that is newly dumped is also more susceptible to wind entrainment as after a period, all exposed, loose material will have been eroded from the site. The following mitigation measures are relevant around areas of stock piling and overburden dumping.

5.2.1 <u>Fugitive dust mitigation</u>

A dust management plan that includes some or all of the following mitigation measures is recommended:

Table 4: Estimated Control Factors fugitive dust emissions

Activity	Control	Emission reduction
Wind erosion from stockpiles	Water sprays	50%
	Wind breaks	30%
	Re-vegetation or total enclosure	99%

Smooth contouring i.e. rounding of the upper edges, to reduce eddy generation under strong wind conditions and limiting the height of stockpiles also assists in fugitive dust reduction. Stockpiles with a long static lifespan should be designed to minimise surface area to volume ratio.

5.3 Vehicle emissions

As with any large industrial or construction activity, vehicular emissions resulting from the use of diesel engines is inevitable.

5.3.1 Vehicle emission mitigation

It is recommended that best practice is followed in terms of limiting vehicle emissions through the proper control and maintenance of vehicles.

6. RESPONSES TO PUBLIC PARTICIPATION QUERIES

6.1.1 <u>How will the rock art situated approximately 500m from the opencast area be impacted on?</u>

The amended plan now has the nearest opencast activity in excess of 2km from the rock art site.
Settling dust is more of an issue for the rock art than floating dust. Settling dust typically has a diameter far larger than PM10 but PM10 is used as an easily modelled indicator of likely flow patterns (as explained earlier).

The modelling results indicate that the rock art area is unlikely to be heavily impacted. In support of this is the fact that, generally, the wind flow is easterly. Ie, the wind generally blows from the rock site, towards the mine. Cumulative impacts over the life of the mine could become a problem however. Thus, precautions against dust contamination should be taken.

6.1.2 Dust suppression: The amount of water that is needed to effectively suppress the dust will result in wetting the area to such an extent that the trucks will not be able to use the roads. The mitigation of dust suppression is not effective and needs to be looked at again.

There are many good chemical dust retardants on the market. However, dust suppression for a mine of this nature requires extensive behavioural as well as structural interventions. Where appropriate, spraying is a cost effective means of suppression, although chemical suppression may be better suited for certain areas. It is essential that issues of dust be central to standard operating procedures on the mine, in particular regarding limiting the speeds of vehicles and the types and timing of activities likely to result in dust emissions.

6.1.3 Is the area in which the proposed mine is to be developed not part of the Pollution Act (As the Vaal Triangle) and as such will the dust pollution be allowed?

The mine falls within the Highveld Priority Area. As such, the mine must have personnel specifically tasked with dust emissions management and must have auditable records of dust levels and methods undertaken to mange dust emissions.

6.1.4 There are houses within the dust footprint – how is this going to be addressed?

It is likely that any dwellings close to the mine boundary may experience some impact from dust originating from mining activity. It is vital that the mine maintains good and open communication with its neighbours in order to properly monitor and respond to any impacts. Small particles (<10µm diameter) can be inhaled and may result in respiratory infections. Although, for technical reasons, PM10 has been used as a modelled indicator for total dust in this study, PM10 inhalation is usually associated with emissions from combustion. Dust impacts from mining operations are more likely to be associated with larger particles.

6.1.5 <u>What will the dust ingress / pollution into the vlei area be – quantify?</u>

It is impossible to accurately quantify dust impacts on any individual receptor. However, the modelled results do indicate a possible impact on surrounding vegetation. For this reason, every effort must be made to include dust mitigation in all aspects of the mine's operation.

6.1.6 <u>What will the impact of dust be on the quality of grazing in the area?</u>

Large particles (>20µm diameter) can cover grazing grass affecting palatability and possibly decreasing livestock food intake. This could affect grazing land that immediately borders the mine. It is thus imperative that every effort be made to control for, and to mitigate against mine entrained dust.

6.1.7 <u>What will the impact of dust be on agricultural activities such as maize?</u>

Settling of large particle dust (>20µm diameter) has been shown to block stomata pores and could result in decreased crop yield. However, these particles typically settle out of the airstream in a matter of minutes, seldom travelling more than a few hundred metres from source.

6.1.8 <u>The seed potatoes cultivated on Groblershoop are susceptible to illnesses. These illnesses can be distributed via dust, water and uncontrolled movement. Al3 farming is totally against the De Wittekrans project</u>

It is not possible to guarantee that any individual farm will or will not be impacted on by dust from the mine. It is recommended that quantification of current dust fall on this area be instituted immediately so as to determine a baseline and thus provide a basis for the quantification of any future impact.

Furthermore, the current haul road borders this farm on two sides. It is highly likely that some dust impact will result on this land, regardless of mitigation measures imposed.

7. CONCLUSIONS

The proposed activities will result in dust emissions, both from mining activities and fugitive emissions from the large areas of previously vegetated land that will now be exposed. Provided sufficient mitigation measures are instigated, it is unlikely that these emissions will exceed South Africa's guidelines for particulate emissions away from the mine's boundaries.

POTENTIAL ENVIRONMENTAL IMPACT	ACTIVITY	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION						RECOMMENDED MITIGATION MEASURES/ REMARKS	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION					
		M	D	S	P	TOTAL	SP		M	D	S	P	TOTAL	SP
Dust	Open cast	6	4	2	4	48	M	Water spraying, behavioural change (speed and activity limits), chemical retardation	2	4	2	4	32	M

Dust emissions are directly related to activity so the above table is unavoidably weighted towards high duration values equalling the life of the mine. Correspondingly, once the mine is decommissioned, and assuming correct decommissioning procedures as pertains to dust are carried out, no impacts should result beyond the life of the mine. With correct mitigation, all of the intensities described above should be kept below guideline levels.