AIR QUALITY

Impact Report

Stuart South– Air quality report

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1. INTRODUCTION

Kijani Green Energy was approached by Cleanstream Environmental Consultants to provide specialist air quality input into the scoping and environmental impact studies to assess the potential impact that the proposed expansion of the Stuart Coal Colliery was likely to have on the surrounding environment.

Kijani is a specialist air quality consultancy with extensive experience in the provision of specialist input into mining related EIAs in South Africa. All relevant staff are fully trained in all aspects of air quality analysis and modelling and are competent to undertake such work in a professional and timely manner.

Furthermore, Kijani hereby declares their independence on this matter, in keeping with the requirements of specialist professionals as outlined by the National Environmental Management Act (NEMA). Kijani works under the auspices of Cleanstream on this project.

2. LOCATION

The Stuart Coal South site is situated approximately 10km east of Delmas on the Mpumalanga Highveld, at 26°08’37.43” S 28°49’20.68” E.

Stuart Coal is an existing mining operation in the Delmas area. The Weltevreden and East Collieries are currently operational. Stuart Coal wish to commence with mining at this site in the near future. Stuart Coal intends to move the coal processing plant from the Weltevreden Colliery where it currently operates to the South Colliery in order to process the coal that will be mined at the new site.

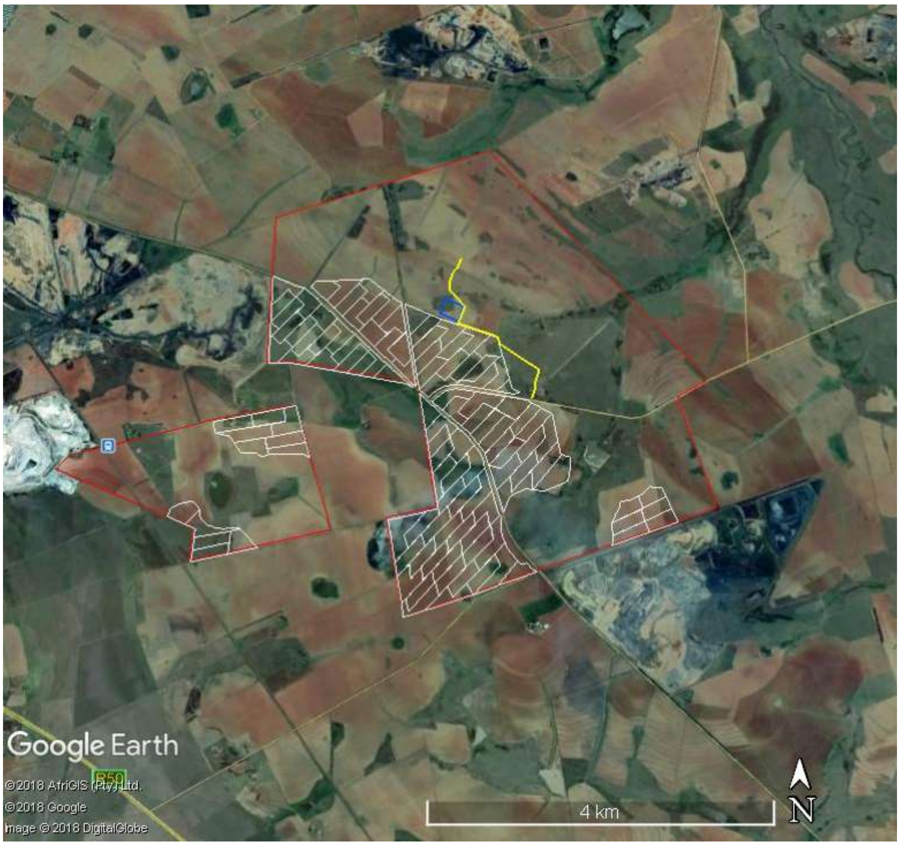

Figure 1. Stuart South mine design and layout: Mine plan, plant area and road

2.1 Legislative review

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 modelling 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.

The National Dust Control Regulations were signed into law on the 1st of November, 2013. An acceptable dustfall rate for a non-residential area is considered to be more than 600 $mg/m^2/day$ but less than 1200 $mg/m^2/day$ (30 day average), with a maximum allowable two exceedences per year, provided these exceedences do not take place in consecutive months.

A dustfall monitoring programme as prescribed in terms of the Regulations must include:

(a) The establishment of a network of dust monitoring points using method ASTM D1739: 1970 (or equivalent), sufficient in number to establish the contribution of the person to dustfall in residential and non-residential areas in the vicinity of the premises, to monitor identified or likely sensitive receptor locations, and to establish the baseline dustfall for the district; and

(b) A schedule for submitting to the air quality officer, dustfall monitoring reports annually or at more frequent intervals if so requested by the air quality officer.[1]

[1] National Dust Control Regulations, National Environmental Management: Air Quality Act, 2004 (Act No. 39 Of 2004), No. R. 827, 1 November, 2013

3. PROCESS DESCRIPTION

The project consists Stuart Coal of an extension of mining operations away from the existing Weltevreden and East Collieries. A coal processing plant will be moved from the Weltevreden Colliery where it currently operates to the South Colliery in order to process the coal that will be mined at the new site. .

4. CLIMATE DESCRIPTION

No long term weather dataset was available for the site in question so OR Tambo International Airport, Johannesburg, Gauteng Province was selected as an acceptable proxy.

Dust emissions are a function of the makeup 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 Stuart South colliery, it is these factors on which the focus lies.

4.1.1 Wind

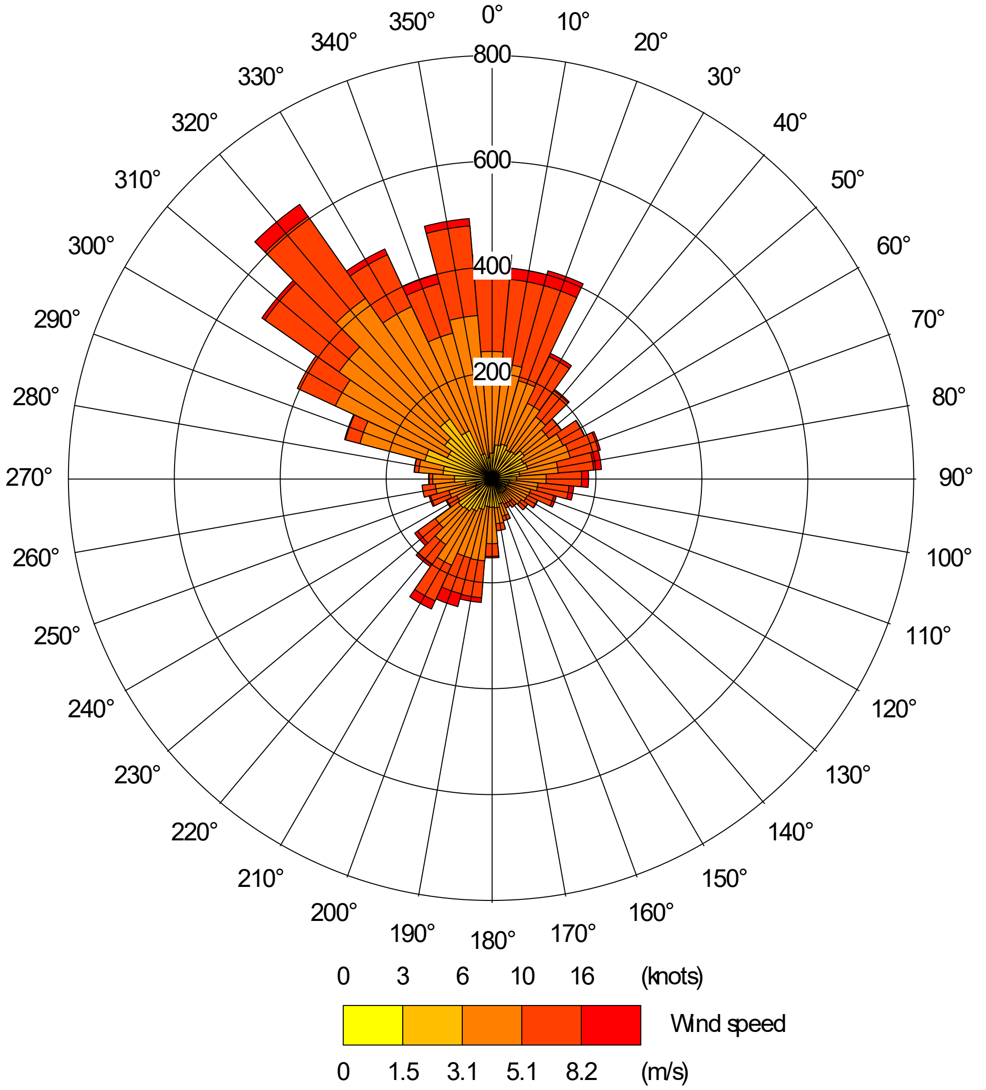

Figure 2. Annual wind rose for Johannesburg (OR Tambo International Airport), Gauteng Province, South Africa (SAWS, 2013).

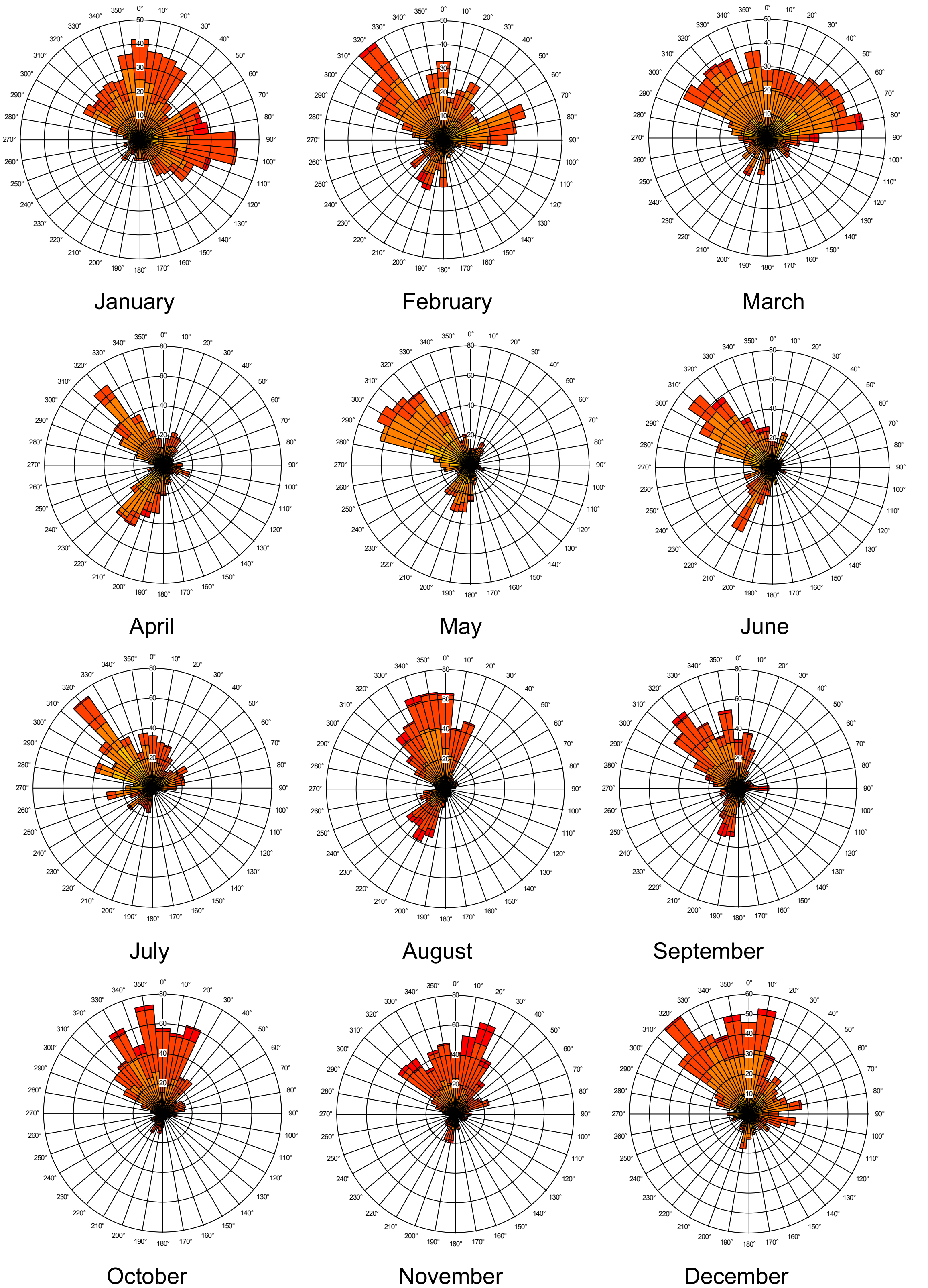

Figure 3. Average monthly wind direction and strength for Johannesburg, Gauteng Province, South Africa (SAWS, 2013)

The prevailing winds are from the north and north-west, with dispersion from the site likely to be predominantly away from nearby residential areas.

4.1.2 Precipitation

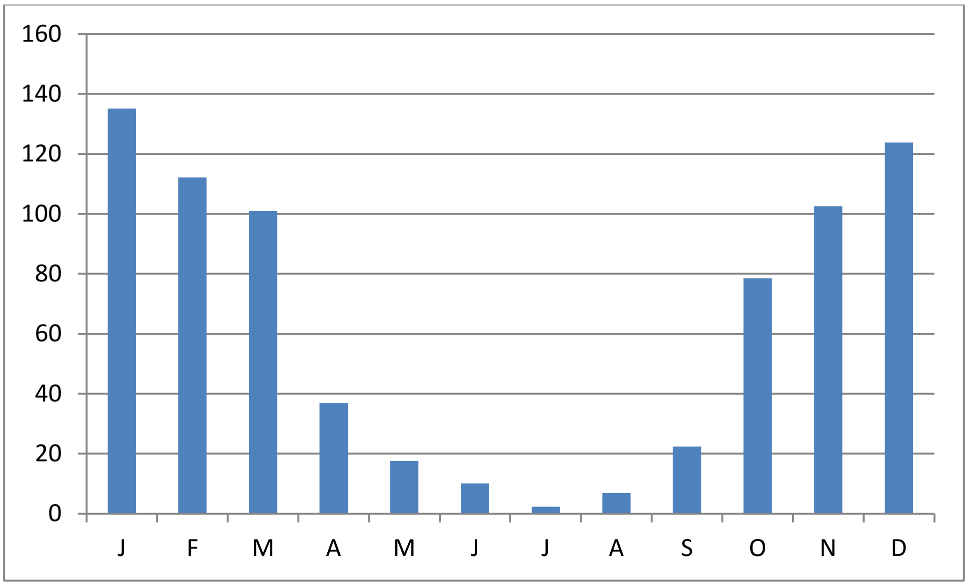

Figure 4: Average monthly rainfall figures for Johannesburg, Gauteng Province, South Africa (SAWS, 1961-1990) (mm per month)

The site is on the Highveld, at an altitude of approximately 1567m above sea level. It is in South Africa's summer rainfall region with an annual average rainfall of 750mm per year. Rain peaks mid- season, in January, while the winter months are characterised by a long and very dry period.

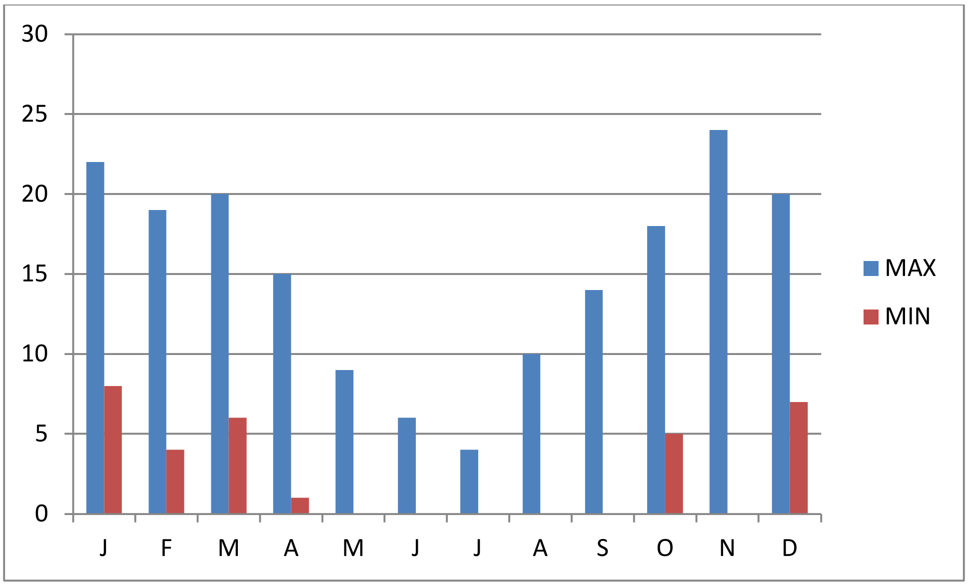

Figure 5: Maximum and minimum monthly rain days (days where precipitation exceeds 0.1mm) for Johannesburg, Gauteng Province, South Africa, South Africa (SAWS, 1961-1990) (number of days per month)

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 September.

4.1.3 Temperature

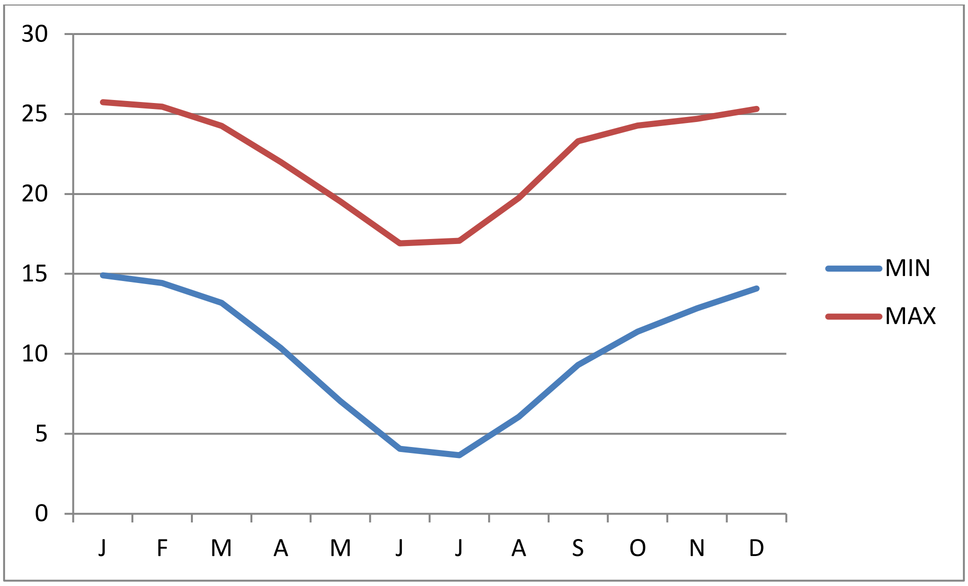

Figure 6: Average minimum and maximum daily temperature (Celsius) for Johannesburg, Gauteng Province, South Africa, South Africa (SAWS, 1961-1990)

The warmest period is December / January, when maximum temperatures average above 26 degrees centigrade while June/July is the coldest period with daytime temperatures averaging 17 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.

4.2 Summary

The site is situated in a high altitude region characterized by 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.

5. METHODOLOGY AND ASSUMPTIONS

Emissions to air during the construction 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.

5.1 Meteorological data

Following discussions with SAWS, the nearest available hourly sequential dataset was identified as being that of OR Tambo International Airport, Johannesburg, for the year 2012, 40km west of the site. This is considered to be a reasonable proxy for the region's climate[2].

5.2 Pollutants

Pollutants to air from a mine under normal operations, such as is proposed, are likely to fall into three main categories:

- Dust;
- Vehicle emissions; and
- Fugitive hydrocarbons from fuel storage.

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

5.2.1 Dust

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; and
- Activities taking place on that surface (transport, loading, blasting and entrainment by the passage of vehicles).

[2] Personal communication, SAWS, 2013

Mining operations result 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.

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 have an adverse effect on local flora through the clogging of stomata.

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.

TSP represents a wide range of particle sizes and types so PM_{10} is modelled in order to at least get a sense of likely areas of impact. It is then reasonable to assume that the areas that could be impacted on by PM_{10} will be the same as those areas that will experience high TSP fall out.

5.3 Dispersion Modelling

Potential emission modelling is undertaken using Cambridge Environmental Research Consultants (CERC)'s latest generation model, the Atmospheric Dispersion Modelling System (ADMS 5). 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 3.1*(2012). Meteorological data is sourced from the South African Weather Services (SAWS).

5.3.1 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 3.1*(2012). 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:

- $E_{kpy,i}$ = 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, %

The bulk of the activity on the proposed site is likely to take place underground so dust impacts directly related to mineral extraction should be minimised. The most significant dust impact is likely to result from the driving of heavy vehicles over unpaved roads. 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)**		**PM10 (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

In order to highlight areas of potential dust impact, inputs were assumed extremely conservatively, so as to maximise indicated emissions. This is done to ensure that any areas that may be impacted are thrown into stark relief and appropriate plans can be drawn up to monitor and, if necessary, mitigate potential emissions.

No background data is available so existing ambient PM_{10} dust was not considered. This has the effect of underestimating the effect of the facility on surrounding areas.

6. RESULTS

When assessing the modelling results, it is important to bear the following in mind: The absolute values of modelled dust emissions may not be a reliable indicator of the values expected in the real world. However, the exercise is valuable in terms of assessing relative values. For example, if an area to one side of a source appears more heavily impacted from dust dispersion, it is reasonable to assume that that will be the case in the real world.

The model was run twice (once for each new alternative) on a 5 000m by 5 000m grid, with centre points at 26°09'07.41"S, 28°49'09.61"E.

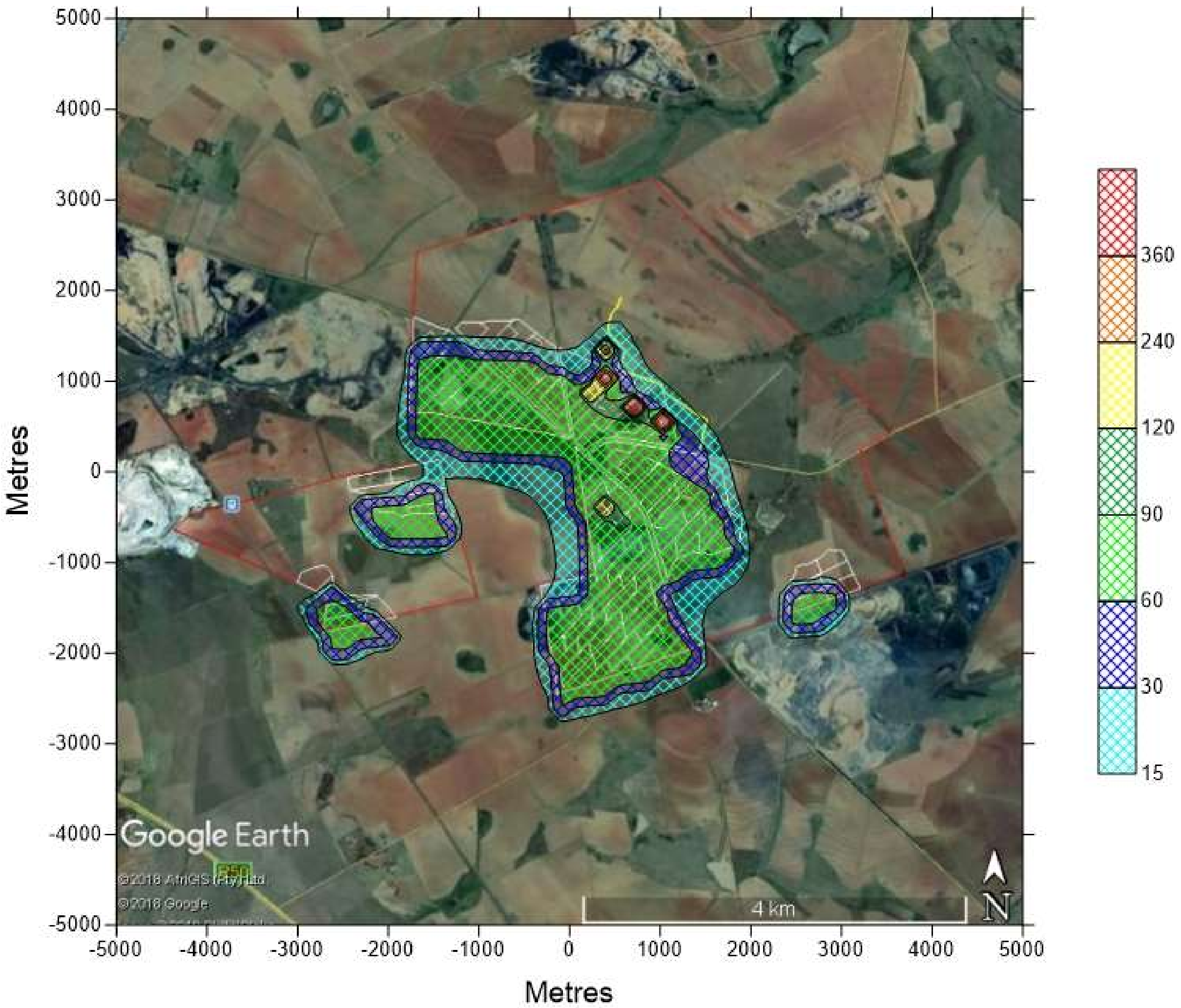

Figure 7: Modelled representation of PM_{10} dispersion from proposed Stuart South mine. Long term averages, 24 hour averaging period, levels indicated in µg/m^3

The representation above indicates that dispersion from the site is likely to be in a southerly to south southeasterly direction, although most of the impacts will only be felt within the immediate vicinity of the emitting activity, specifically the transport roads and the processing areas.

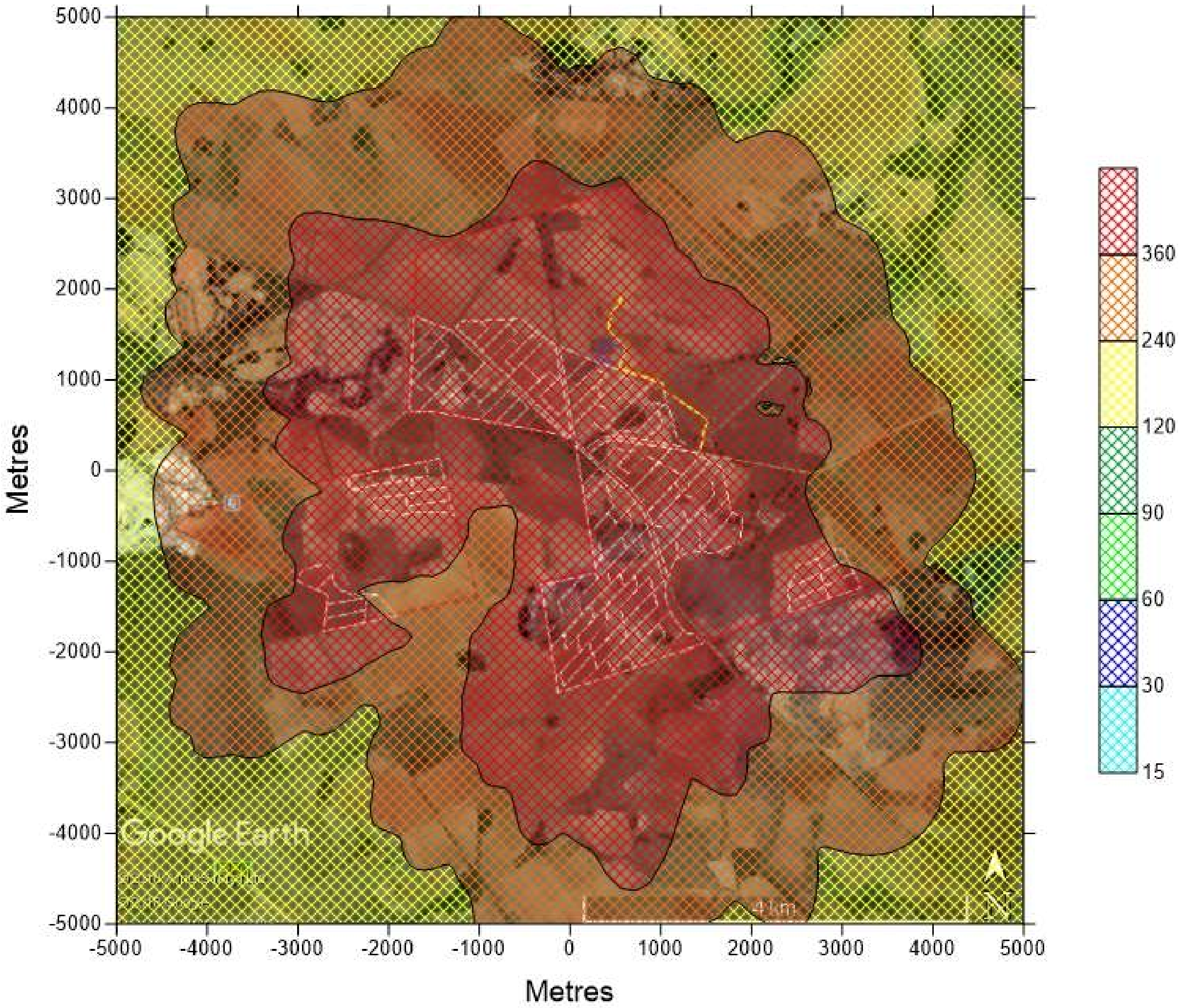

Figure 8: Modelled representation of 100th percentile PM_{10} dispersion from proposed Stuart South mine. Long term averages, 24 hour averaging period, levels indicated in µg/m^3

The figure above indicates the highest concentration of PM_{10} dust indicated for each modelled point for the 8640 time steps of the model. This indicates at least one incidence of high ambient dust per year for the entire operation footprint.

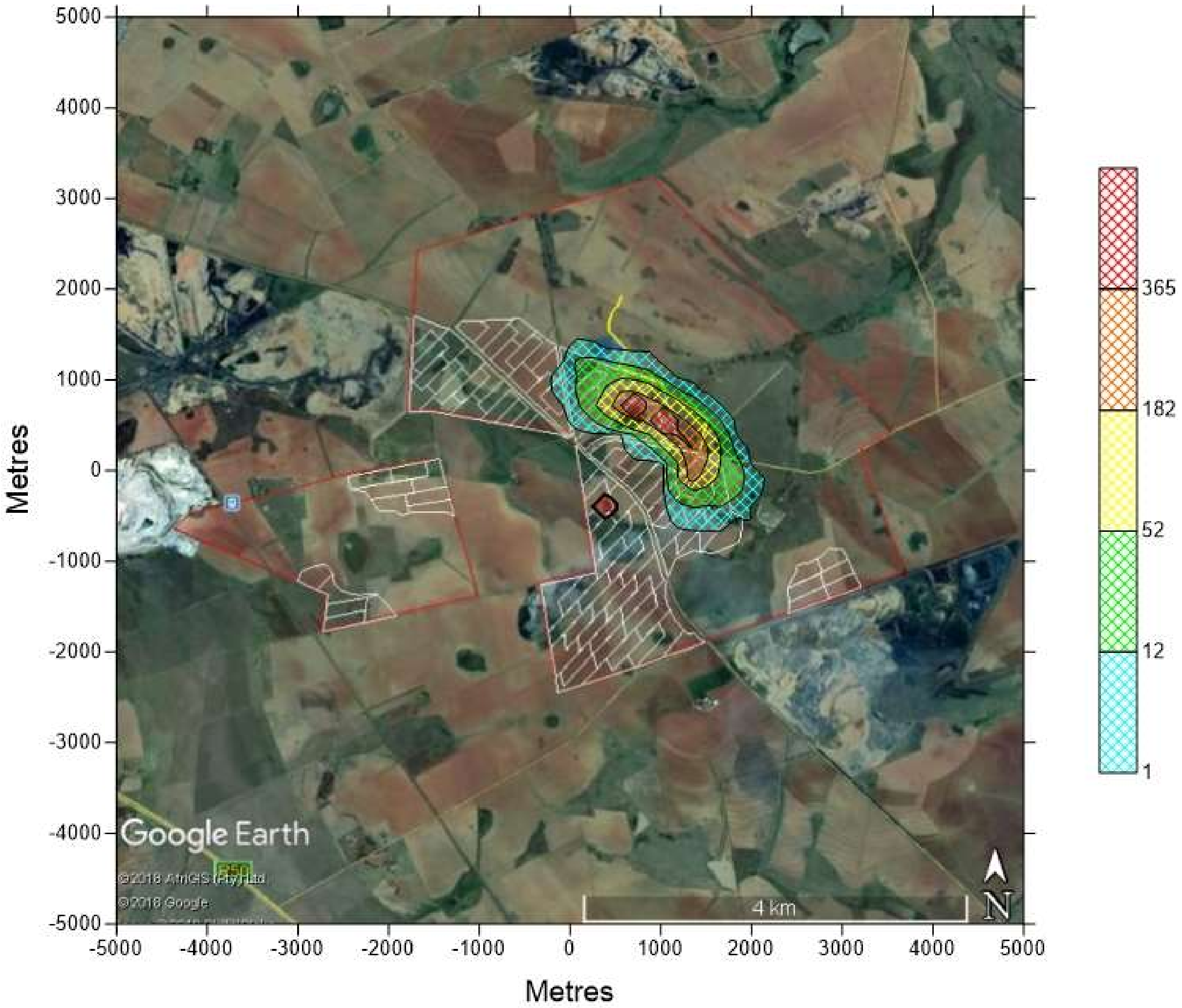

Figure 9: Modelled representation of incidences of ambient PM_{10} levels from proposed Stuart South mine exceeding the 180 µg/m^3 level.

Figure 9 shows the likely number of exceedences in any one year of the 180 µg/m^3 level. Regular exceedences in the region of daily occurrences can be expected along the transport routes and in the immediate vicinity of heavy machinery in the processing areas and in the active mining areas.

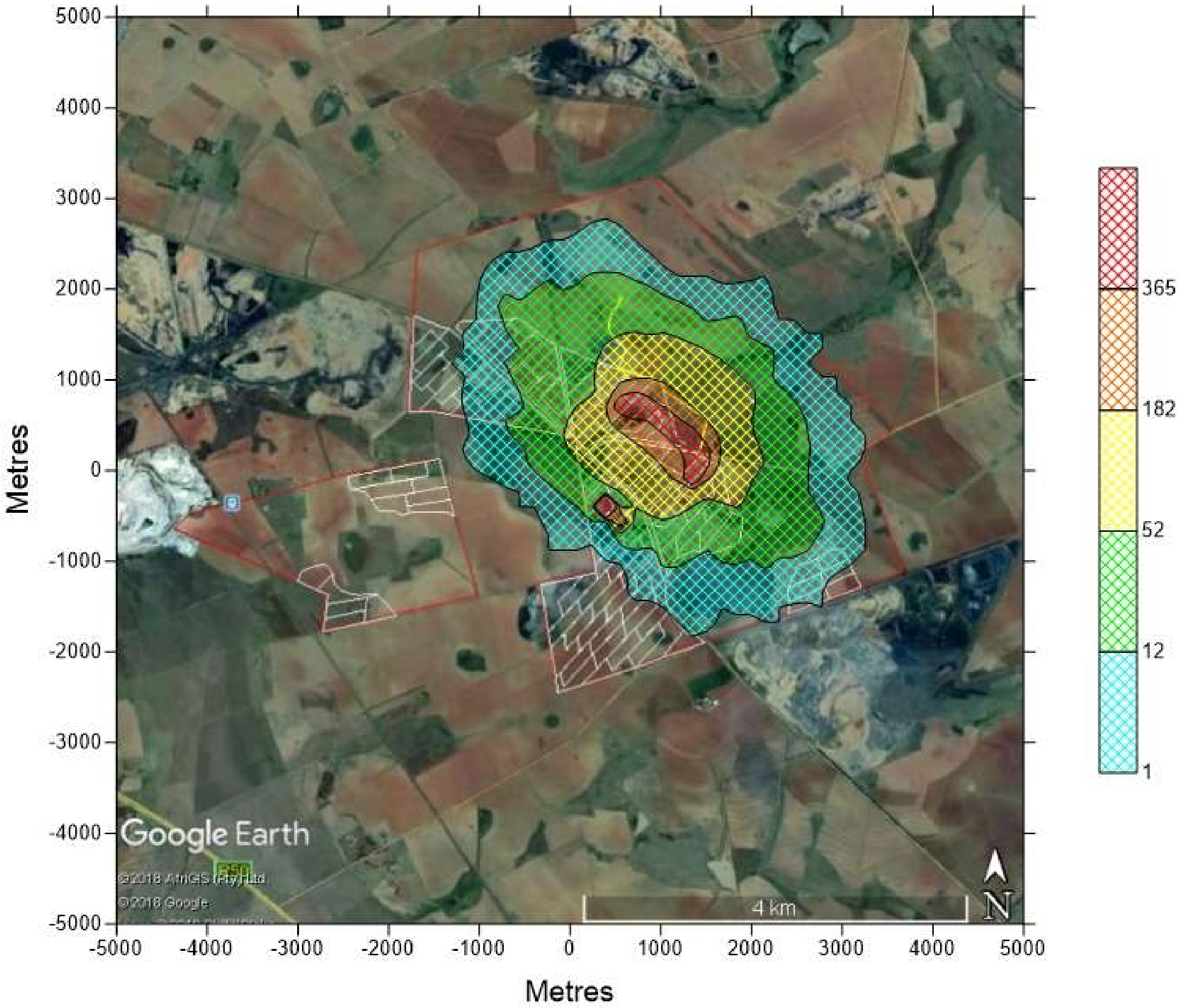

Figure 10: Modelled representation of incidences of ambient PM_{10} levels from proposed Stuart South mine exceeding the 60 µg/m^3 level.

Figure 10 shows the likely number of exceedences in any one year of the 60 µg/m^3 level. Regular exceedences in the region of daily occurrences can be expected along the transport routes and in the immediate vicinity of heavy machinery in the processing areas and in the active mining areas with weekly occurrences extending over most of the active site.

6.1 Results conclusion

For practical purposes, PM_{10} and not TSP was modelled in this study. A general rule of thumb is that TSP emissions approximate three times the levels experienced from PM_{10}, with fallout closer to the source. With this in mind, it seems unlikely that these activities alone will result in dust fallout exceeding the 1200 mg/day stipulated in the legislation. However, in the cases where the dust is made up of black coal dust, the perceived impact will be higher than would be the case for dust formed from surface material.

During dry and windy periods, particularly during the ploughing season when agricultural activities may add to the ambient dust load, this guideline may be approached, particularly along the transport routes and near the processing plant and active mine areas, and so it is recommended that dust control makes up an integral part of the mine's management plan.

7. POTENTIAL IMPACTS AND MITIGATION

7.1 Transport routes

The road is indicated as a potential significant contributor to dust at the mine. It is unclear if this route will be used to transport coal to the processing plant. If this is the case, then every effort to manage traffic flow on this route and to bind the surface appropriately should be made.

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 road dust emission is exponential. It is impossible to monitor dust quantitatively in real time, so the following subjective classification of road dust defect becomes useful in alerting operators to real time conditions.

Table 2: Classification of 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.

The following is recommended:

- Speed control on the transport route be strictly enforced;

- The road be surfaced with a dust retardant material to limit wheel-entrained dust; and
- Monitoring of fall out dust be implemented at one or two points along the road, specifically on the south side to which most entrained dust will disperse.

7.2 Mining operations

The heavy machinery necessary in the active mine areas and on coal stockpiles and dumps is an unavoidable source of soil disturbance and subsequent dust. Mitigation is difficult but a few management measures are possible to limit the impact of the dust on surrounding areas. Primary among these is an efficient mining process that limits the number of times that material needs to be transferred as loading and off-loading is a significant dust source.

The following is recommended:

- Monitoring of fence-line fallout dust;
- Spraying of haul roads with dust retardant;
- Strictly enforced speed limits on haul roads and waste dumps; and
- Limiting of transfer of material.

7.3 Monitoring

It is recommended that a dust monitoring program be implemented, with critical areas of focus being the road, the processing plant and areas adjacent to active mining areas. Dispersal is primarily to the south so monitoring should reflect this by focusing to the south of potential sources.