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Exxaro Coal Pty (Ltd) Grootegeluk Short-Term Stockpiles Amendment Project

Air Quality Report

Project Number:

EXX3666

Prepared for:

Exxaro Coal (Pty) Ltd (Grootegeluk)

September 2016

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Report Type:	**Air Quality Report**
Project Name:	**Exxaro Coal Pty (Ltd) Grootegeluk Short-Term Stockpiles Amendment Project**
Project Code:	**EXX3666**

Name	Responsibility	Signature	Date
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EXECUTIVE SUMMARY

Exxaro Coal (Pty) Ltd (Exxaro), Grootegeluk Coal Mine (Grootegeluk) is contracted to supply coal to Eskom's Medupi and Matimba power stations, both in Lephalale, Limpopo Province. Off-take of Eskom coal has slowed due to construction delays and thus Exxaro requires additional stockpiling space to accommodate the excess coal on site. Digby Wells was requested by Exxaro Coal (Pty) Ltd to carry out an Air Quality Impact Assessment (AQIA) for the proposed Short Term Stockpile Amendment at the Grootegeluk Mine.

Digby Wells Environmental (Digby Wells) was appointed by Exxaro (Pty) Ltd, Grootegeluk Coal Mine (Grootegeluk) to amend the environmental authorisations for the Grootegeluk Infrastructure Expansion Project in 2014. The permitting documents were submitted to Limpopo Department of Economic Development, Environment and Tourism (LEDET) and Department of Mineral Resources (DMR).Exxaro were granted an Environmental Authorisation in October 2014 and August 2015.

The approved uses of the stockpile areas will need to be changed to also utilise the laydown Area, GG10B, and multiproduct stockyard footprints to stock excess Eskom-grade coal only (in the form of a compacted coal stockpile), for an approximate period of five years, until Medupi station is fully operational. These changes will also include the extension of the GG10B Stockyard footprint by approximately 12.8 hectares (ha) by including the current D8 rail loop area, which will be decommissioned with the construction of the new loadout area, also referred to as the extension area.

Grootegeluk Coal Mine is an operational mine located on the remaining extent of the farm Daarby 458 LQ and Enkelbult 462 LQ near Lephalale in the Limpopo Province.

Data limitations, assumptions and exclusions associated with this study are listed below:

- The impact assessment was limited to particulates $PM_{2.5}$, PM_{10}, and dust fallout,
- Although the proposed Project will also result in the emissions of gaseous pollutants from vehicle exhausts, these were considered negligible.
- Due to the unavailability of local emission factors, United States Environmental Protection Agency (US EPA) and Australian National Pollutant Inventory (NPI) emission factors were utilised.
- Particle size distributions of coal were adopted from similar operations.
- Emissions considered in this assessment are those related to wind erosion and materials handling activities associated with the proposed amendments.

Three years' worth of modelled meteorological data (2013 – 2015) was used to assess background weather parameters in the Project area. The predominant wind direction is from northeast (24%) and north northeast (20%) respectively, with calm conditions occurring for 5.2% of the time. The maximum monthly temperature of 33.6°C was observed in December,

with monthly average temperature ranging from 12.7°C in July, to 25.4°C in December. The annual total of monthly average precipitation of 350 mm was observed.

Ambient air quality data from the Waterberg Bojanala Priority Area monitoring station in Lephalale owned by the Departmental of Environmental Affairs (DEA) and hosted by South African Air Quality Information System (SAAQIS) was used to assess background air quality scenario in the area for PM_{10} and $PM_{2.5}$ for the period 2012 to June 2016. In general, the ambient concentrations of PM_{10} measured at the station were within the South African daily standard (75 µg/m^3), with few exceedances observed. The ambient $PM_{2.5}$ measurements from the monitoring station were generally below the current standard of 40 µg/m^3. However, some exceedances were recorded during the month of August each year.

The dust deposition rates measured in the vicinity of Grootegeluk mine are within the recommended standard with isolated exceedances observed. All the sites were complaint with no violation of the recommend standard.

An emissions inventory was established, taking cognizance of the different activities associated with the proposed amendments. Emission rates from the aforementioned were used as input data in the dispersion model simulations.

Predicted ground level concentrations at the project boundary and selected sensitive receptors were compared against the South African standards for particulate pollutants.

The model predications presented in this report have shown that pollutants level due the proposed amendments - dust fallout, PM_{10} and $PM_{2.5}$ will not exceed regulatory standards. It is worth mentioning that predicted concentrations are not in exceedance at the mine boundary and at surrounding sensitive receptors. The main findings of this AQIA study are summarised as follows:

- Daily PM_{10} – Predicted levels are within the regulatory standard in the Project area and surrounding receptors respectively. The predicted daily concentration at the mine boundary of 10.2 µg/m^3 was below the current daily standards of 75 µg/m3 (without mitigation).
- Annual PM_{10} – Predicted annual concentration of 0.9 µg/m^3 was within the current standard (40 µg/m3) at the mine boundary and surrounding receptors.
- Daily $PM_{2.5}$ – Predicted concentrations at the mine boundary were within the current South African standard (40 µg/m^3), with a maximum of 3 µg/m^3 simulated. However, with appropriate mitigation applied, concentrations of this pollutant can be reduced below the levels predicted.
- Annual $PM_{2.5}$ – Predicted annual concentrations did not exceed the current South African limit (20 µg/m^3) at any point on the mine boundary and at sensitive receptors. The highest predicted at the mine boundary was 0.3 µg/m^3.
- The predicted dust deposition rates due to the proposed amendments at the mine boundary were within the residential and non-residential limit of 600 mg/m^2/day and 1200 mg/m^2/day respectively.

The main outcome of this air quality impact assessment is that emission sources associated with the proposed amendment will have minimal impacts on the ambient – fallout dust, PM_{10} and $PM_{2.5}$ load and on the overall cumulative air quality impacts. Irrespective of the aforementioned, suitable monitoring and mitigation measures should be factored into the day to day operation of the mine.

Mitigation measures are recommended in the Environmental Management Plan tailored to the proposed activities. Implementation of the suggested mitigation measures will ensure compliance with regulatory requirements.

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LIST OF ABRBREVIATIONS

APPA	Air Pollution Prevention Act
AQIA	Air Quality Impact Assessment
ASTM	American Society for Testing and Materials
^oC	Degrees Celsius
DEA	Department of Environmental Affairs
EIA	Environmental Impact Assessment
Km	Kilometre
M	Metre
m^2	Metre squared
Mg	Milligram
MM5	Mesoscale model - Fifth generation
mamsl	metres above mean sea level
NAAQS	National Ambient Air Quality Standards
NEMA	National Environmental Management Act
NEM:AQA	National Environmental Management: Air Quality Act
$PM_{2.5}$	Particulate Matter less than 2.5 microns in diameter
PM_{10}	Particulate Matter less than 10 microns in diameter
Ppb	parts per billion
PSU/NCAR	Pennsylvania State University / National Center for Atmospheric Research
SANS	South African National Standards
SAWS	South African Weather Service
SAAQIS	South African Air Quality Information System
TSP	Total Suspended Particulates
USEPA	United States Environmental Protection Agency
WBPA	Waterberg – Bojanala Priority Area

WHO	World Health Organisation

1 Introduction

Digby Wells was requested by Exxaro Coal (Pty) Ltd (hereafter Exxaro) to carry out an Air Quality Impact Assessment (AQIA) for the proposed Grootegeluk Short Term Stockpile Amendment Project on the remaining extent of the farm Daarby 458 LQ and the remaining extent of the farm Enkelbult 462 LQ, near Lephalale in the Limpopo Province.

1.1 Project Background

Exxaro owns multiple mining operations, including Grootegeluk Coal Mine (hereafter Grootegeluk), which has been in operation since 1982 in the Limpopo Province. Grootegeluk is located approximately 18 km outside of Lephalale and is contracted to supply coal to Eskom's Matimba power station and the Medupi power station. Due to delays in the start-up of Medupi the off-take of Eskom coal has slowed and Exxaro requires additional stockpiling space to accommodate the excess coal on site.

Exxaro applied to expand certain infrastructure within the mine boundary area, referred to as the Grootegeluk Coal Mine Infrastructure Expansion Project. Exxaro submitted Applications in terms of the National Environmental Management Act (NEMA), 1998 (Act No. 107 of 1998) and Minerals and Petroleum Resources Development Act (MPRDA), 2002 (Act No. 28 of 2002) to include the following activities / expansions within the mine boundary:

- Expansion of the rail loop, load out stations and associated infrastructure;
- Expansion of the existing coal stockyard and stockpiles;
- Expansion of the fuel storage depot;
- Expansion of beneficiation plants and associated infrastructure;
- New road and conveyors to fines recovery area;
- New gate and hard park area; and
- Expansion of ancillary infrastructure and new 33 kV power line.

The aforementioned 2014 amendment was also associated with the expansion of the existing coal product stockpiles. The following stockpiles and stockyards were included in the applications and approved:

- GG 6/2 stockyard;
- GG 10 stockyards;
  - Conical Stock pile;
  - Stockyard A and
  - Stockyard B;
- Multi-product overflow stockyard

The Grootegeluk Coal Mine Infrastructure Expansion Project was authorised in terms of the NEMA and the Environmental Impact Assessment Regulations of 2010[1], (which have been repealed). The Limpopo Department of Economic Development, Environment and Tourism (LEDET), and the Record of Decision are dated 27 October 2014, with reference number 12/1/9/1-W89 (refer to Figure 1-1). The Department of Mineral Resources (DMR) Environmental Management Programme (EMP) Amendment approval was granted on the 28 August 2015.

Exxaro proposed a phased authorisation approach for the amendments that are being requested. Exxaro proposes to amend the existing Authorisation relevant to the Grootegeluk Mine Infrastructure Expansion Project (which included the expansion of the GG10 Stockyards and several other stockpile areas).

The purpose of these amendments is to allow Exxaro to legally stockpile Eskom-grade coal currently being mined from the upper coal benches at the Grootegeluk Mine. In summary the two phases included the following:

- Phase 1: Amendment of the GG10A stockyard for temporary use - The amendment of the GG10A stockyard area with the capacity of 400,000m^3 to include the alternative of a temporary 2 Mt compacted Power Station Coal Stockpile in the same footprint area.
- Phase 2: Amend the GG10B stockyard area - The amendment of the GG10B stockyard to include the additional area inside the loop not originally included. To also amend the use of the multi-product overflow stockpiles to stacking and loading areas. The additional 1.1mil stockpiles area in the footprint of the original Coke and Co-gen area will need to be included as an additional area.

Further to what has been noted above regarding the requested amendment, Exxaro received approval from Department of Water Affairs (DWS) and DMR for Phase 1 of the project on the 5th May 2016 and 7th July 2016 respectively. This part of the project and associated specialist studies conducted is in support of the Phase 2 amendment that is being requested for in terms Section 31 of the 2014 NEMA Regulations applies as this is an amendment to an existing Environmental Authorisation. Thus the information contained within this specialist report is specific to the Phase 2 amendment process, however does make reference to Phase 1 with respect to the areas assessed.

[1] Dated 18 June 2010

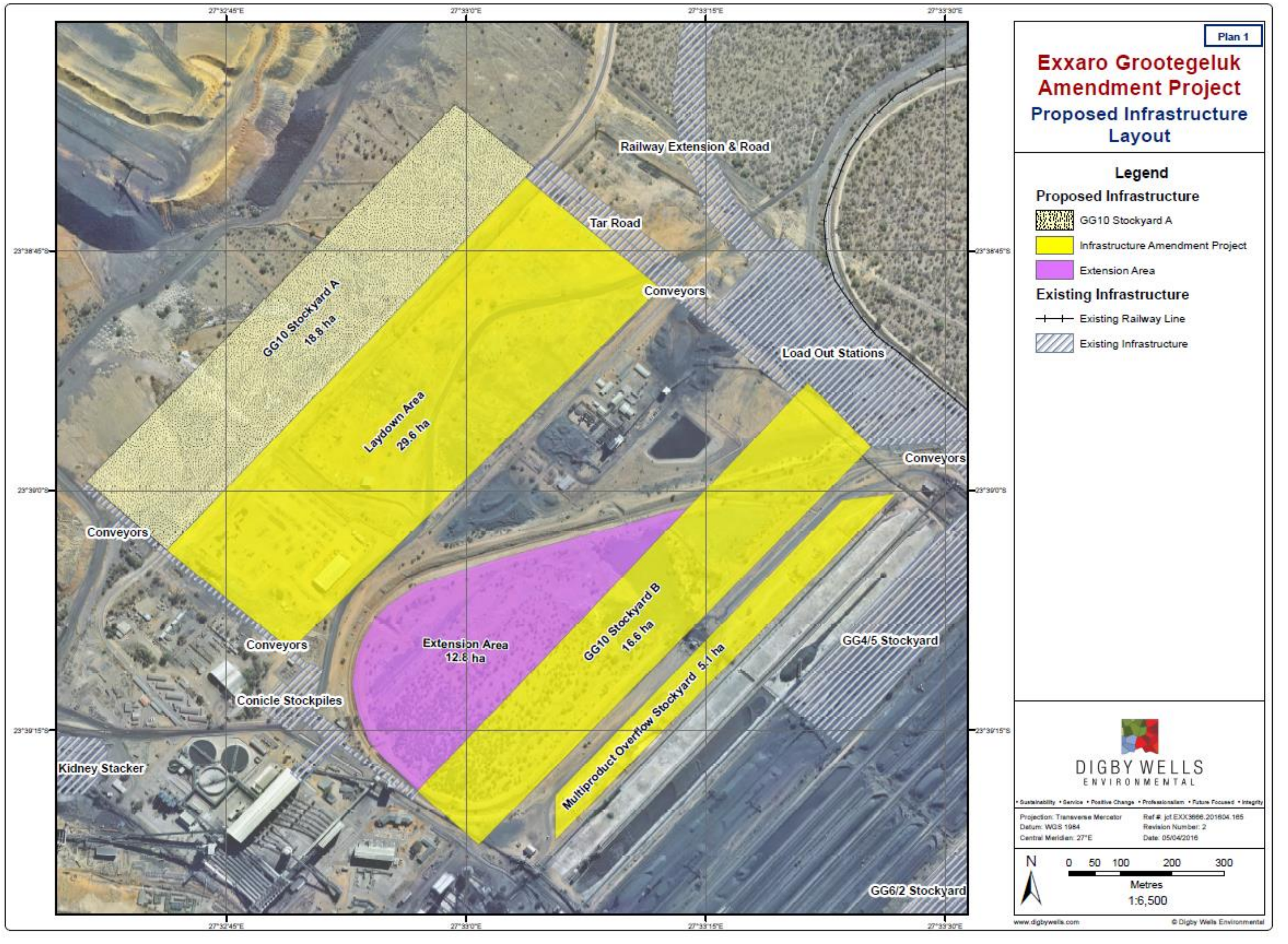

Figure 1-1: Site layout of the proposed Grootegeluk Short Term Stockpile Amendment Project

After the expansion of the infrastructure, the Laydown Area, GG10B, and Multiproduct Stockyard footprints will stock excess Eskom-grade coal only, for an approximate period of five years, until Medupi power station is fully operational. The expansion includes the extension of the GG10B Stockyard footprint including the internal area of the discontinued rail loop (approximate extent shown in purple – 12.8 ha). It is assumed the amount of coal to be stockpiled in this area will total six megatons.

The proposed changes will require authorisation in terms of Regulation 31 of the NEMA (amendment process), as well as a Section 21(g) Authorisation in terms of the National Water Act, 1998 (Act No 36 of 1998).

1.2 Terms of Reference (ToR)

Digby Wells was required to assess potential impacts associated with Grootegeluk Short Term Stockpile Amendment Project on ambient air quality of the area.

As part of the ToR, the following was conducted:

- Baseline assessment;
  - Evaluation of site specific meteorology;
  - Evaluation of background ambient air quality data; and
  - Review of possible health and environmental implications of potential pollutants.
- Emissions inventory;
- Dispersion modelling;
- Impact assessment; and
- Recommendation of mitigation measures incorporating Best Practicable Environmental Option.

2 Details of the Specialist

Winnie Ngara completed her BSc (Hons) degree at the National University of Science and Technology, Bulawayo, Zimbabwe; and MSc in Environmental Science from the University of Johannesburg. She has been in the Atmospheric Science field for 4 years. She has conducted a number of air quality impact assessment studies and is conversant with the dispersion modelling packages AERMOD and CALPUFF.

3 Assumptions and Limitations

Assumptions and limitations associated with this study are listed below:

- The impact assessment was limited to particulates ($PM_{2.5}$, PM_{10}, and dust fallout) from wind erosion and material handling processes for the operational phase;
- Due to the unavailability of local emission factors, the US-EPA and Australian NPI emission factors were utilised in the emissions inventory;

- This assessment was based on the proposed Grootegeluk Short Term Stockpile Amendment Project infrastructure only;
- Constant emission rates were assumed for wind erosion;
- The current study did not consider open areas;
- The haul roads treated with Dust-A-Side was not considered in the study.

4 Location of Site

Grootegeluk Coal Mine is situated approximately 20 km to the west of Lephalale, in the Waterberg District Municipality in the Limpopo Province (Figure 4-1: Regional setting). The project area is located close to the Matimba and Medupi (currently under construction) power station.

The surrounding sensitive receptors (residential communities) that could possibly be impacted include:

- Marapong – approximately 9 km to the east;
- Onverwacht – approximately 16 km to the south east; and
- Lephalale – approximately 21 km to the east.

4.1 Waterberg- Bojanala Priority Area (WBPA)

The Waterberg-Bojanala Priority Area (WBPA) was declared the third priority area by the Minister in terms of GNR 495 on 15 June 2012. The WBPA encompasses the Waterberg District in Limpopo Province and its six Local Municipalities and three Local Municipalities in the Bojanala Platinum District in the North West. The Waterberg is the largest of the 5 provinces in the western side of the Limpopo Province while the Bojanala Platinum is the largest of the four District Municipalities within the North West (C&M Consulting Engineers, 2013). The following are the municipalities in the WBPA Table 4-1.

Table 4-1: Municipalities within the WBPA

Province	District Municipality	Local Municipality
Limpopo	Waterberg	Thabazimbi
		Modimolle
		Mogalakwena
		Bela Bela
		Mookgopong
		Lephalale
North West	Bojanala Platinum	Moses Kotane
		Rustenburg
		Madibeng

Source: Umoya-NILU, 2014

The Waterberg district has three forms of settlements which are villages, informal settlements and farms. The mining activities are located around the periphery while tourism and game farming are located around the centre of the District. This area was considered pristine and after the virgin coal resources were identified, new developments were proposed such as Medupi power station. There are various other new power stations which are proposed in the future. There was an urgency to be proactive and to take precautionary measures prior to these developments to ensure that the ambient air quality standards are met (DEA, 2012). The current air pollution sources of concern in the Waterberg District are:

- Dust from mines, quarries, and brickworks;
- Burning of solid waste at waste disposal sites, informal waste dumps;
- Tailpipe emissions from combustion engines.

The Bojanala Platinum District has several sources of emissions, such as: heavy industry, refinery, power station, motor vehicles, small industries and households (burning of coal for domestic fuel use). Air pollution sources of concern in the Bojanala District are quite similar to above mentioned.

Due to aforementioned sources of pollutions, it became critical that Priority Air Quality Management Plan for the area be developed. A Priority Air Quality Management Plan includes the establishment of emissions reduction strategies and intervention programmes based on the findings of a baseline characterisation of the area. Grootegeluk Mine is located within the footprint demarcated as the Waterberg Priority Area and a contributing source to ambient air pollution.

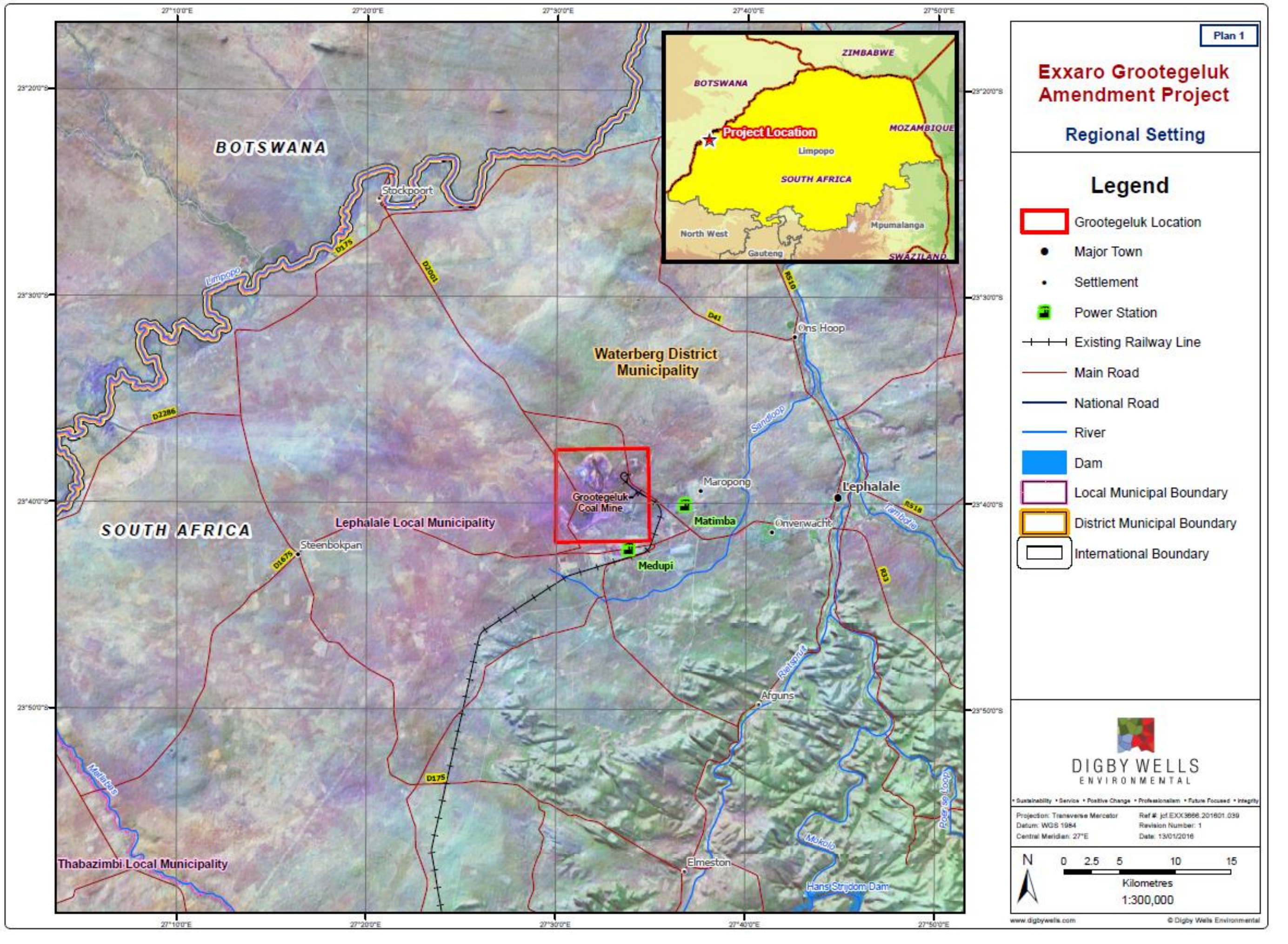

Figure 4-1: Grootegeluk Regional Setting

Currently, the Department of Environmental Affairs operates four ambient monitoring stations the priority area which are referred to as the Waterberg-Bojanala Ambient Air Quality Monitoring Network. This network previously comprised of three air quality monitoring stations bought by the Department of Environmental situated in Lephalale, Thabazimbi and Mokopane. The fourth station which was recently installed in located in Brits. The following parameters are measured at each station: PM_{10}, $PM_{2.5}$, sulphur dioxide (SO_2), nitric oxide (NO), nitrogen dioxide (NO_2), nitrogen oxides (NO_x), ozone (O_3), carbon monoxide (CO), benzene (C_6H_6), toluene and xylene. In addition to the above, meteorological data for wind speed; wind direction, ambient temperature, relative humidity, rainfall, solar radiation and barometric pressure are also measured.

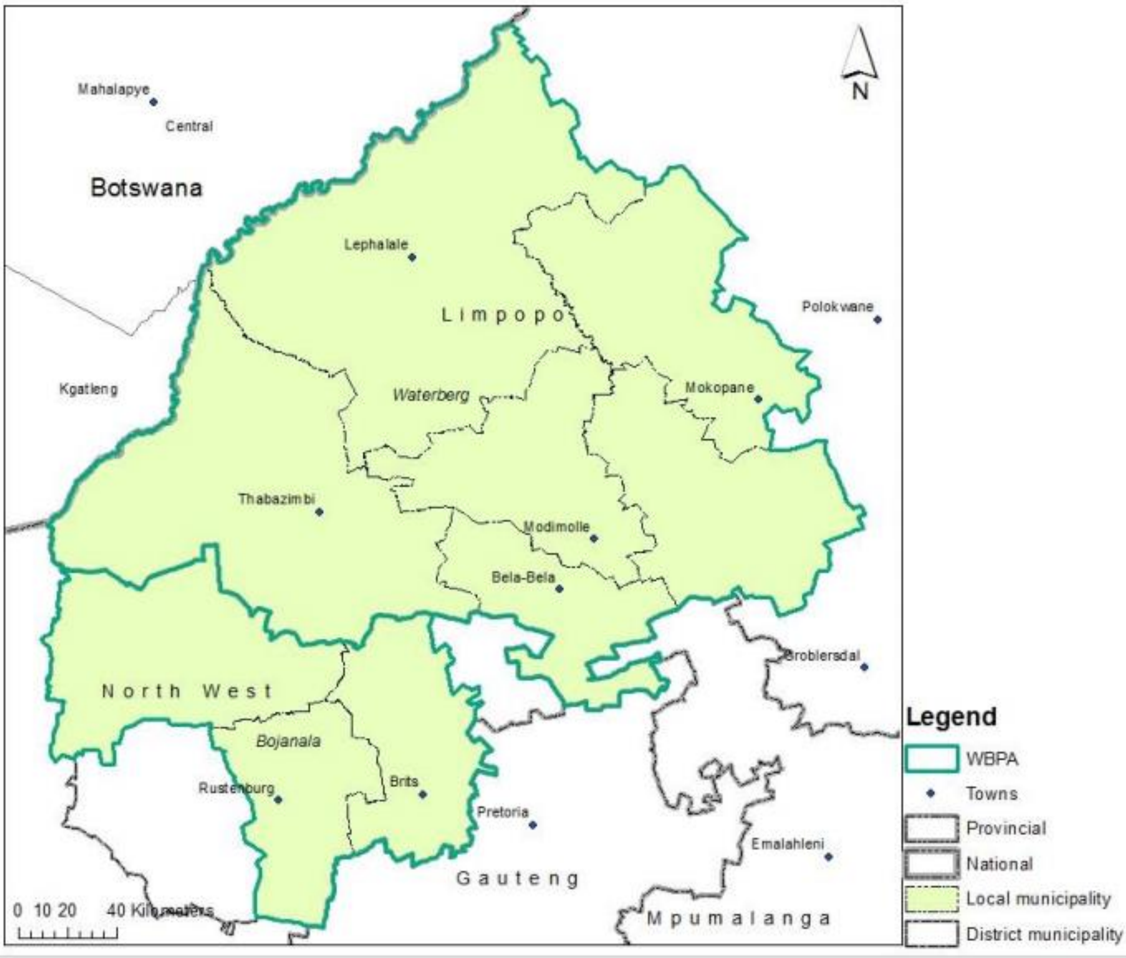

Figure 4-2: Waterberg- Bojanala Priority Area (Umoya-NILU, 2014)

5 Baseline Assessment

5.1 Climate and Meteorological Overview

Ambient air quality in this region of South Africa is strongly influenced by regional atmospheric movements, together with local climatic and meteorological conditions. The most important of these atmospheric movements over Limpopo region are the north easterly inflows originating from over the Indian Ocean. During winter, there are high incidences of low-speed recirculation over the interior of the sub-continent.

There are distinct summer and winter weather patterns that affect the dispersal of pollutants in the atmosphere. In summer, unstable atmospheric conditions result in mixing of the atmosphere and rapid dispersion of pollutants. Summer rainfall also aids in removing pollutants through wet deposition. Precipitation reduces wind erosion potential by increasing the moisture content of exposed surface materials–this represents an effective mechanism for suppressing wind-blown dust. Rain-days are defined as days experiencing 0.1 mm or more rainfall.

In contrast, winter is characterised by atmospheric stability caused by a persistent high-pressure system over South Africa. This dominant high-pressure system results in subsidence, causing clear skies and a pronounced temperature inversion over interior of South Africa. This inversion layer traps pollutants from near surface sources in the lower atmosphere, which results in reduced dispersion and poorer air quality. Preston-Whyte and Tyson (1988) described the atmospheric conditions in the winter months as highly unfavourable for the dispersion of atmospheric pollutants. Emissions from elevated sources, such as from tall stacks, remain stratified in the mid-troposphere and have a reduced probability of reaching the surface with high concentrations near the source.

In the absence of site specific meteorological records, three years' worth of hourly weather MM5 modelled meteorological data (2013-2015) from Lakes Environmental Software was analysed and used to generate wind rose plots and determine the local prevailing weather conditions. This dataset, from the Pennsylvania State University / National Center for Atmospheric Research (PSU/NCAR) meso-scale model is a limited-area, non-hydrostatic, terrain-following sigma-coordinate model designed to simulate or predict meso-scale atmospheric circulation. This data, obtained for a point (23.65895S, 27.556725E) in the proposed project area, has been tested extensively and has been found to be accurate. . Generally, a data set of greater than 90% completeness is required for that month/year to be considered representative of the assessed area (SANS, 2011).

Dispersion of atmospheric pollutants is a function of the prevailing wind characteristics at any site. The vertical dispersion of pollution is largely a function of the wind field. The wind speed determines both the distance of downward transport and the rate of dilution of pollutants. The generation of mechanical turbulence is similarly a function of the wind speed, in combination with the surface roughness (Jacobson, 2005).

The amount of particulate matter generated by wind is highly dependent upon the wind speed. Below the wind speed threshold for a specific particle type, no particulate matter is liberated, while above the threshold, particulate matter liberation tends to increase withwind speed. The amount of particulate matter generated by wind is dependent also on the surface properties, for example, whether the material is crusted, the fraction of erodible particles, and the particle size distribution (Fryrear et al., 1991).

Wind roses generally comprises of 16 spokes which represent the frequencies and the directions from which winds blew during the period. The colours reflect the different categories of wind speeds. The dotted circles provide information regarding the frequency of occurrence of wind speed and different categories. The figures at the bottom of the legend represent the frequency at which calms occurred (periods with wind speed <0.5 m/s).

The spatial and annual variability in the wind field for the Exxaro Project area is evident in Figure 5-1. The dominant winds are blowing from northeast (24%) and north of northeast (20%) respectively.

There is some diurnal variation in the meteorological data shown in Figure 5-2. The predominant wind direction is from east of northeast at night time, east northeast in the morning, northeast in the afternoon and east of northeast in the evening.

The seasonal variability in wind direction is depicted in Figure 5-3. The seasonal signature is similar to the diurnal patterns with winds from the east of northeast, the northeast sector dominating the wind regime.

Calm conditions (wind speeds <0.5 m/s) occurred 5.2% of the time. Wind class frequency distribution per sector is given in Figure 5-4 and Table 5-1.

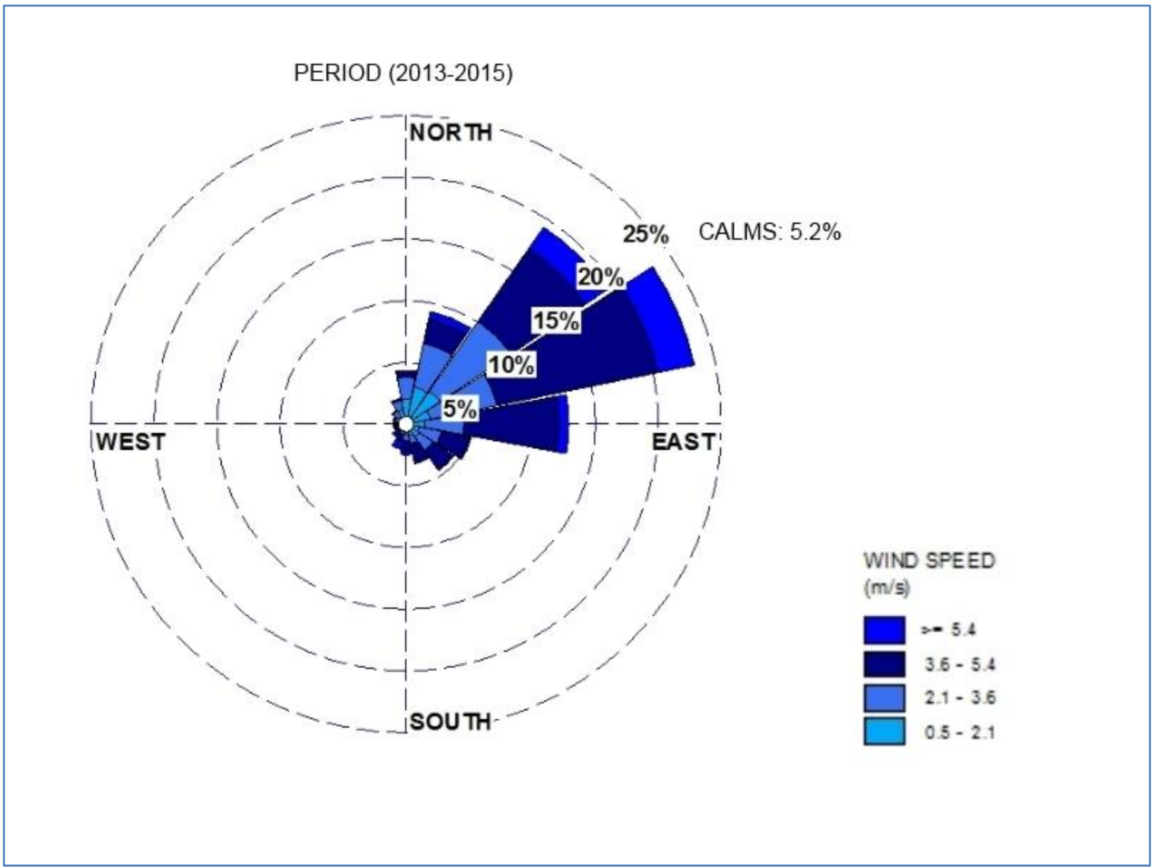

Figure 5-1: Surface wind rose at the Grootegeluk Short Term Stockpile Amendment Project Site

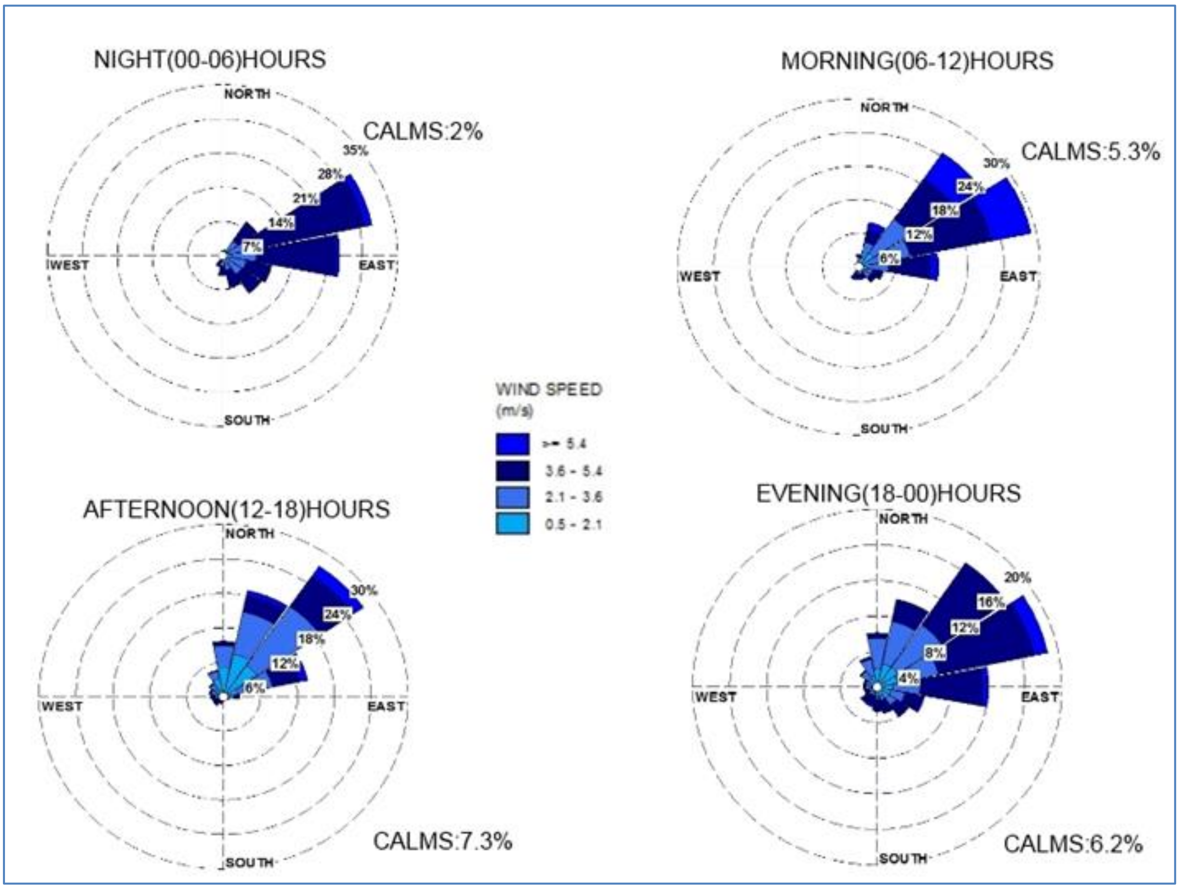

Figure 5-2: Diurnal variations of wind at night-time: 00:00 – 06:00 (top left), morning 06:00 – 12:00 (top right), afternoon 12:00 – 18:00 (bottom left) and evening 18:00 – 00:00 (bottom right).

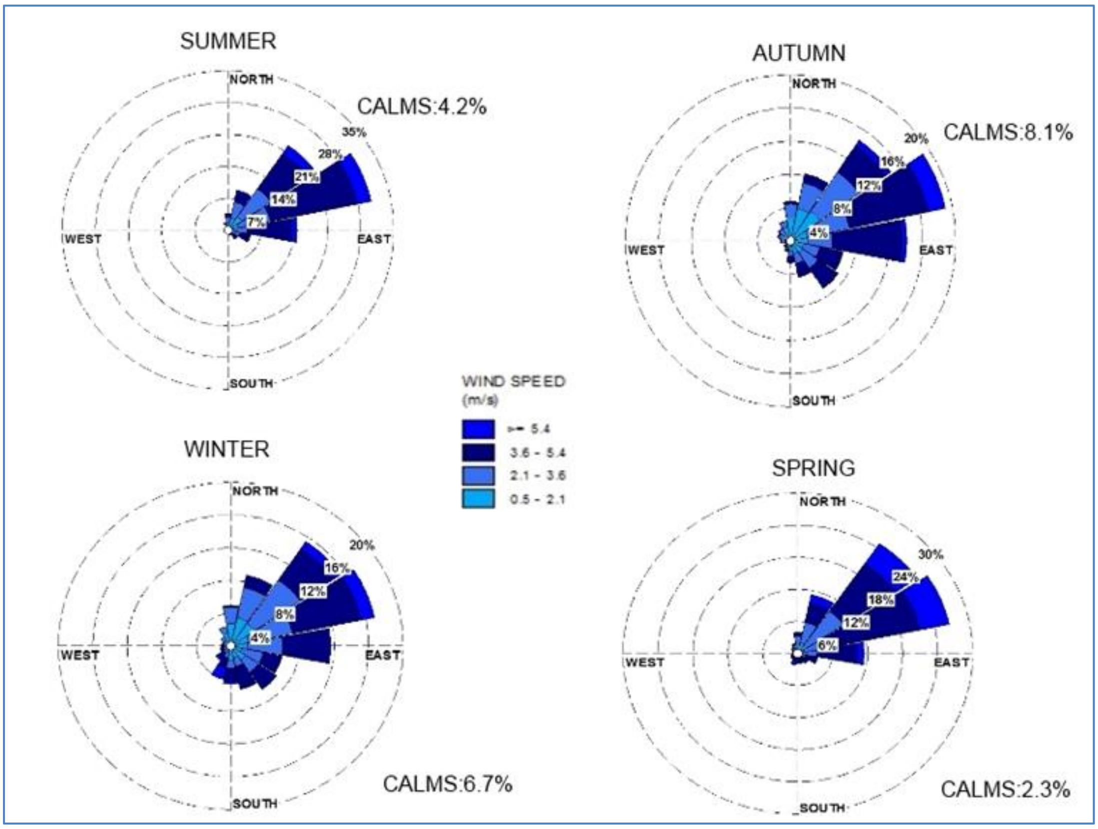

Figure 5-3: Seasonal variability of winds in summer (December – February); autumn (March – May); winter (June – August) and spring (September – November).

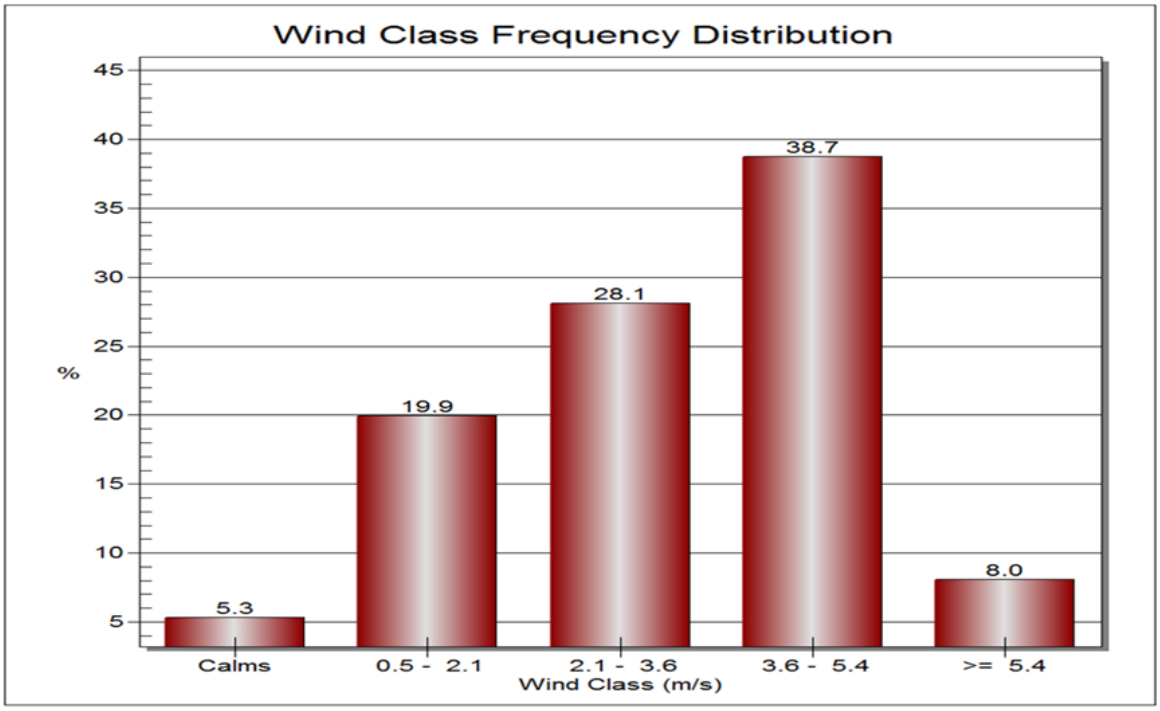

Figure 5-4: Wind Class Frequency Distribution for Grootegeluk modelled data

Table 5-1: Wind class frequency per distribution

	Direction	Wind classes (m/s)				
		0.5 - 2.1	2.1 - 3.6	3.6 - 5.4	>5.4	Total (%)
1	N	2.07	1.72	0.49	0.05	4.33
2	NNE	3.06	3.60	2.07	0.57	9.30
3	NE	3.22	6.83	7.13	2.09	19.28
4	ENE	1.94	5.40	13.01	2.93	23.27
5	E	1.47	3.10	7.52	0.78	12.87
6	ESE	1.06	1.81	2.24	0.13	5.24
7	SE	1.22	1.34	1.92	0.08	4.56
8	SSE	0.92	0.70	1.53	0.12	3.27
9	S	0.86	0.51	0.92	0.22	2.51
10	SSW	0.53	0.33	0.61	0.62	2.09
11	SW	0.40	0.30	0.45	0.19	1.34
12	WSW	0.35	0.33	0.24	0.10	1.02
13	W	0.35	0.40	0.19	0.07	1.02
14	WNW	0.55	0.38	0.13	0.03	1.09
15	NW	0.73	0.53	0.11	0.02	1.39

	Direction	Wind classes (m/s)				
		0.5 - 2.1	2.1 - 3.6	3.6 - 5.4	>5.4	Total (%)
16	NNW	1.21	0.78	0.16	0.01	2.17
	Sub-Total	19.93	28.07	38.71	8.01	94.74
	Calms					5.26
	Missing/Incomplete					0
	Total					100

5.1.1 Temperature

The monthly maximum and average temperature for the project area is given in Table 5-2 and Figure 5-5. The maximum temperatures were observed from October to February with the month of December recording the highest of 33.6°C.The monthly averages ranged from 12.7°C in July, to 25.4°C in December. Annual average temperature for the Project site is given as 20.2°C.

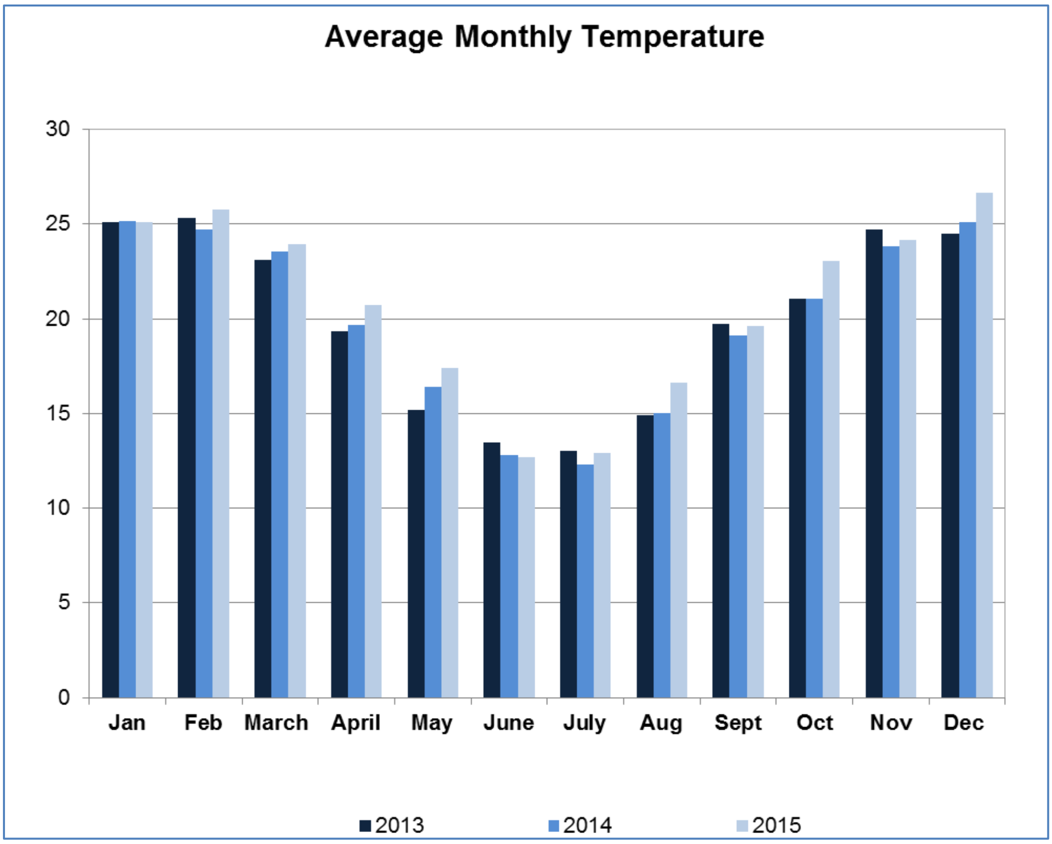

Figure 5-5: Average monthly temperature

Table 5-2: Monthly temperature records

Temp(°C)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Monthly Max.	33.0	33.0	32.2	29.3	24.6	22.6	22.8	26.4	29.7	32.2	33.4	33.6	29.2
Monthly Ave	25.1	25.3	23.5	19.9	16.3	13.0	12.7	15.5	19.5	21.7	24.2	25.4	20.2

5.1.2 Relative Humidity

The data in Table 5-3 are representative of the relative humidity for the proposed Project area. The annual maximum and the annual average are given as 98.8% and 63.7% respectively. Some days within the months from April to October the relative humidity reach 100%. However, the monthly averages on the other hand show the relative humidity are higher in the winter months. In general, the relative humidity is above 50 % for the whole year, with the highest of 75% observed in the month of July (Figure 5-6)

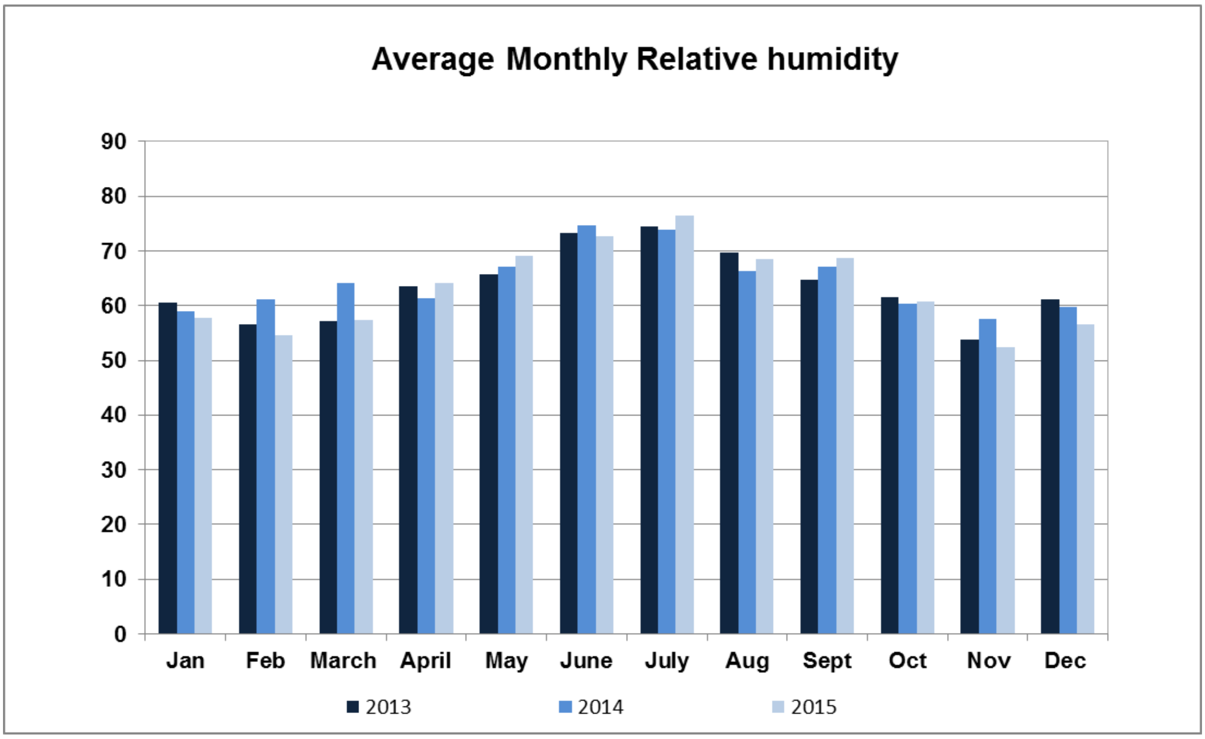

Figure 5-6: Average monthly relative humidity

Table 5-3: Average monthly relative humidity

Relative Humidity (%)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Monthly Ave	59.1	57.4	59.5	63.0	67.3	73.5	74.9	68.2	66.8	60.8	54.6	59.2	63.7
Monthly Max	98.0	97.0	97.3	100.0	100.0	100.0	100.0	100.0	100.0	100.0	95.7	97.0	98.8

5.1.3 Precipitation

Figure 5-7 shows the total monthly rainfall and the annual total for the Project area. Monthly rainfall was heavy in the November, December and January. The annual total rainfall for the project area is 637 mm.

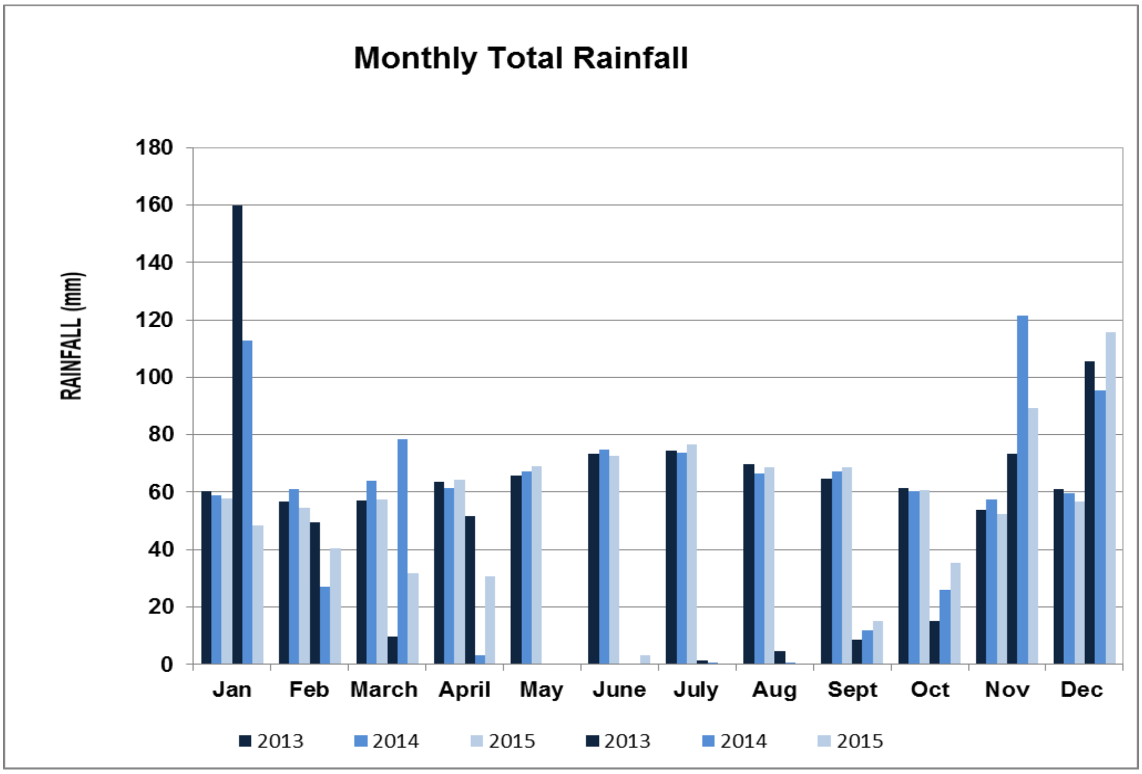

Figure 5-7: Total monthly rainfall.

Table 5-5: Monthly precipitation record (mm)

Precipitation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
Total Monthly Rainfall (Max)	160	50	78	52	0	3	1	5	15	35	121	116	637

5.2 Air Quality

Major atmospheric pollutants in the vicinity of the proposed Grootegeluk Amendment area will be influenced by several local and regional pollutants signature, which include:

- Emissions from coal-fired power plants;
- Operational opencast mines in the area;
- Residential and agricultural activities in the vicinity.

In terms of Air Quality, the main pollutants of concern will be associated with particulate matter i.e. emissions from power plants, dust generated from exposed mining areas, agricultural activities and vehicular movement on unpaved, dry and dusty roads.

5.2.1 Dust Fallout

Dust deposition data is crucial as measurements are used to assess monthly, seasonal, and inter-annual variability in air quality – pre and during mining operations. The amount of dust collected at any given time is a function of the rate of deposition, which may vary widely depending on meteorological factors discussed in section 5.1 such as wind speed and direction and rainfall. The dust fallout sampling, analyses, comparison and interpretation is conducted according to the recommended 1929:2011 (ASTM1739-98 reapproved 2010).

The deposition results are illustrated by means of tables and graphs expressed in the units of $mg/m^2/day$ averaged over a 30 day period. In terms of dust deposition standards, a four-band scale: residential, industrial, action and alert thresholds and permissible frequency of exceedances described in SANS1929:2011 was applied prior to the released of the National Environmental Management: Air Quality Act, 2004 (Act.39 of 2004) - National Dust Control Regulations (NDCR, 2013).

The Minister of Water and Environmental Affairs, released on the 01 November 2013 the National Dust Control Regulation, in terms of Section 53, read with Section 32 of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004). In line with National Dust Control Regulation, the National Department of Environmental Affairs published the acceptable dust fallout standards for residential and non-residential areas.

The New National Dust fallout standard is given in the Table 5-4 below.

Table 5-4: Acceptable dust fall rates as measured (NEMAQA - NDCR, 2013)

Restriction Areas	Dust fall rate (mg/m^2/day, 30-days average)	Permitted Frequency of exceeding dust fall rate
Residential Area	D < 600	Two within a year, not sequential months
Non-Residential Area	600 < D < 1200	Two within a year, not sequential months

Dust falls that exceed the specified rates but that can be shown to be the result of some extreme weather or geological event shall be discounted for the purpose of enforcement and control. Such an event might typically result in excessive dust fall rates across an entire metropolitan region, and not be localized to a particular operation. Natural seasonal variations, for example the naturally windy months each year, will not be considered extreme events for this definition (SANS 1929:2011).

Any person who conducts any activity in such a way as to give rise to dust in quantities and concentrations that may exceed the dust fall standard (Table 5-4) set out in regulation 3 must, upon receipt of a notice from an air quality officer, implement a dust fall monitoring programme (NDCR, 2013).

In the National Dust Control Regulations, terms like target, action and alert thresholds have been omitted. Another notable observation was the reduction of the *margin of tolerance* from the usual three to two incidences within a year (NDCR, 2013). The National Dust Control Regulation actually adopted a more stringent approach than previously standard, and would require dedicated mitigation plans now that it is in force.

A dust monitoring network is up and running in the vicinity of Grootegeluk mining activities and results are used to assess deposition rate in the area. Results from the past three years of monitoring are incorporated in this report. The dust monitoring sites, with site ID and coordinates are depicted in presented in Table 5-5 and in Figure 5-8 below.

Table 5-5: Grootegeluk dust monitoring coordinates

ID	Longitude	Latitude
GGD01	27° 34' 20"E	23° 38' 48"S
GGD02	27° 34' 26"E	23° 37' 29"S
GGD03	27° 30' 58"E	23° 38' 35"S

GGD04	27° 29' 32"E	23° 40' 16"S
GGD05	27° 29' 59"E	23° 41' 1"S
GGD06	27° 30' 35"E	23° 41' 58"S
GGD07	27° 32' 23"E	23° 41' 35"S
GGD08	27° 33' 43"E	23° 41' 36"S
GGD09	27° 32' 10"E	23° 37' 34"S
GGD10	27° 33' 39"E	23° 37' 47"S
GGD11	27° 35' 19"E	23° 41' 5"S
GGD12	27° 35' 7"E	23° 39' 57"S
GGD13	27° 33' 18"E	23° 38' 51"S
GGD14	27° 33' 4"E	23° 39' 1"S
GGD15	27° 33' 7"E	23° 38' 54"S

Results from the monitoring network are presented in Table 5-6, Table 5-7 and

Table 5-8 respectively. The graphs showing the dust deposition rates compared to the relevant standards are presented (Figure 5-9, Figure 5-10 and Figure 5-11).

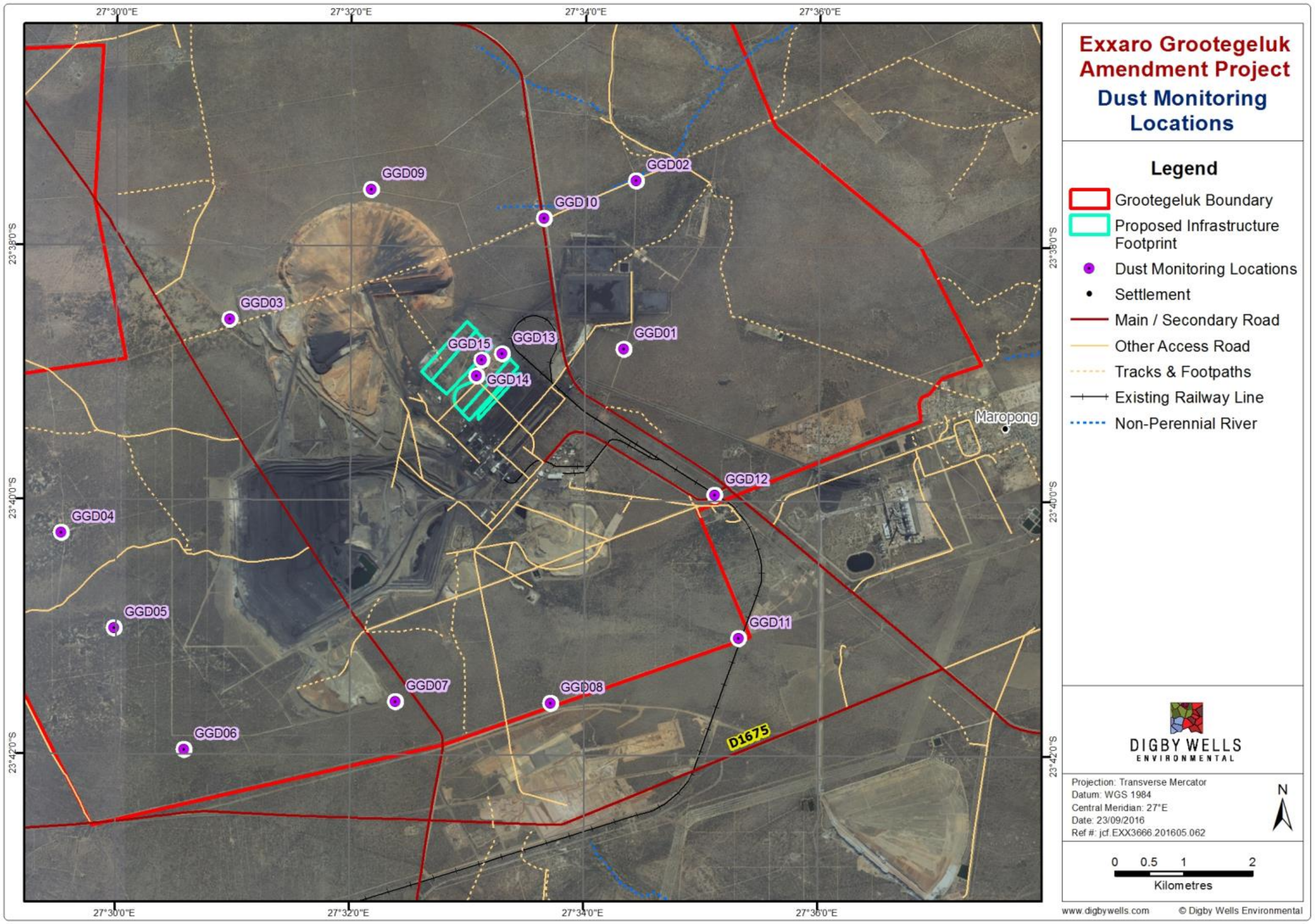

Figure 5-8: Exxaro Grootegeluk dust monitoring points

Table 5-6: 2014 Dust fallout rates for Exxaro (mg/m2/day, 30 day average)

Dust levels measured in mg/m2/day, 30 day average										
	Mar	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
GGD 01	248	59	4590	115	99	111	148	112	0	141
GGD 02	163	24	60	109	69	121	200	221	221	46
GGD 03	1370	351	242	134	90	95	92	197	0	180
GGD 04	245	327	96	136	77	191	347	105	105	346
GGD 05	483	316	174	342	188	216	185	162	162	533
GGD 06	661	96	71	62	229	116	73	117	117	251
GGD 07	235	272	83	63	84	61	444	151	151	149
GGD 08	231	124	129	205	145	80	90	107	107	95
GGD 09	519	38	78	226	107	1330	75	375	0	934
GGD 10	590	139	117	126	119	123	106	127	127	76
GGD 11	252	192	239	423	258	272	111	160	160	98
GGD 12	229	156	92	120	96	97	82	75	75	104
GGD 13	0	0	0	163	443	562	901	853	853	820
GGD 14	0	0	0	538	239	195	461	1110	1110	734
GGD 15	0	0	0	834	410	456	872	879	879	**3980**

*0 = No data

Table 5-7: 2015 Dust fallout rates for Exxaro (mg/m2/day, 30 day average)

Dust levels measured in mg/m2/day, 30 day average												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
GGD 01	61	95	45	90	89	259	125	104	262	52	88	178
GGD 02	36	60	37	52	64	82	80	127	89	38	96	163
GGD 03	194	201	208	56	162	216	184	120	180	121	94	204
GGD 04	205	296	0	260	837	266	307	304	363	115	280	322
GGD 05	292	336	402	316	568	437	492	419	276	1189	393	538
GGD 06	126	148	117	114	250	147	195	214	208	75	95	199
GGD 07	54	106	0	77	118	114	229	97	227	60	90	133
GGD 08	77	105	106	77	201	143	169	136	153	50	219	73
GGD 09	800	**1370**	170	**1470**	128	0	190	135	73	280	312	1050
GGD 10	106	204	177	104	271	201	315	242	206	118	81	159
GGD 11	178	159	258	103	191	186	303	193	310	131	190	266
GGD 12	92	138	104	66	169	89	74	101	130	49	78	119
GGD 13	641	543	532	454	577	408	692	406	568	885	**1870**	1180
GGD 14	140	293	253	282	549	373	316	294	277	178	522	242
GGD 15	351	236	396	325	518	496	492	384	355	447	162	310

*0 = No data

Table 5-8: 2016 Dust fallout rates for Exxaro (mg/m2/day, 30 day average)

Dust levels measured in mg/m2/day, 30 day average				
	Jan	**Feb**	**Mar**	**Apr**
GGD 01	178	105	313	0
GGD 02	163	114	0	0
GGD 03	204	180	101	120
GGD 04	322	980	109	0
GGD 05	538	491	193	345
GGD 06	199	0	55	0
GGD 07	133	59	83	73
GGD 08	73	0	28	124
GGD 09	1050	215	21	325
GGD 10	159	125	23	83
GGD 11	266	346	0	123
GGD 12	119	140	21	17
GGD 13	1180	714	522	151
GGD 14	242	146	107	**1270**
GGD 15	310	167	11	495
*0 = No data				

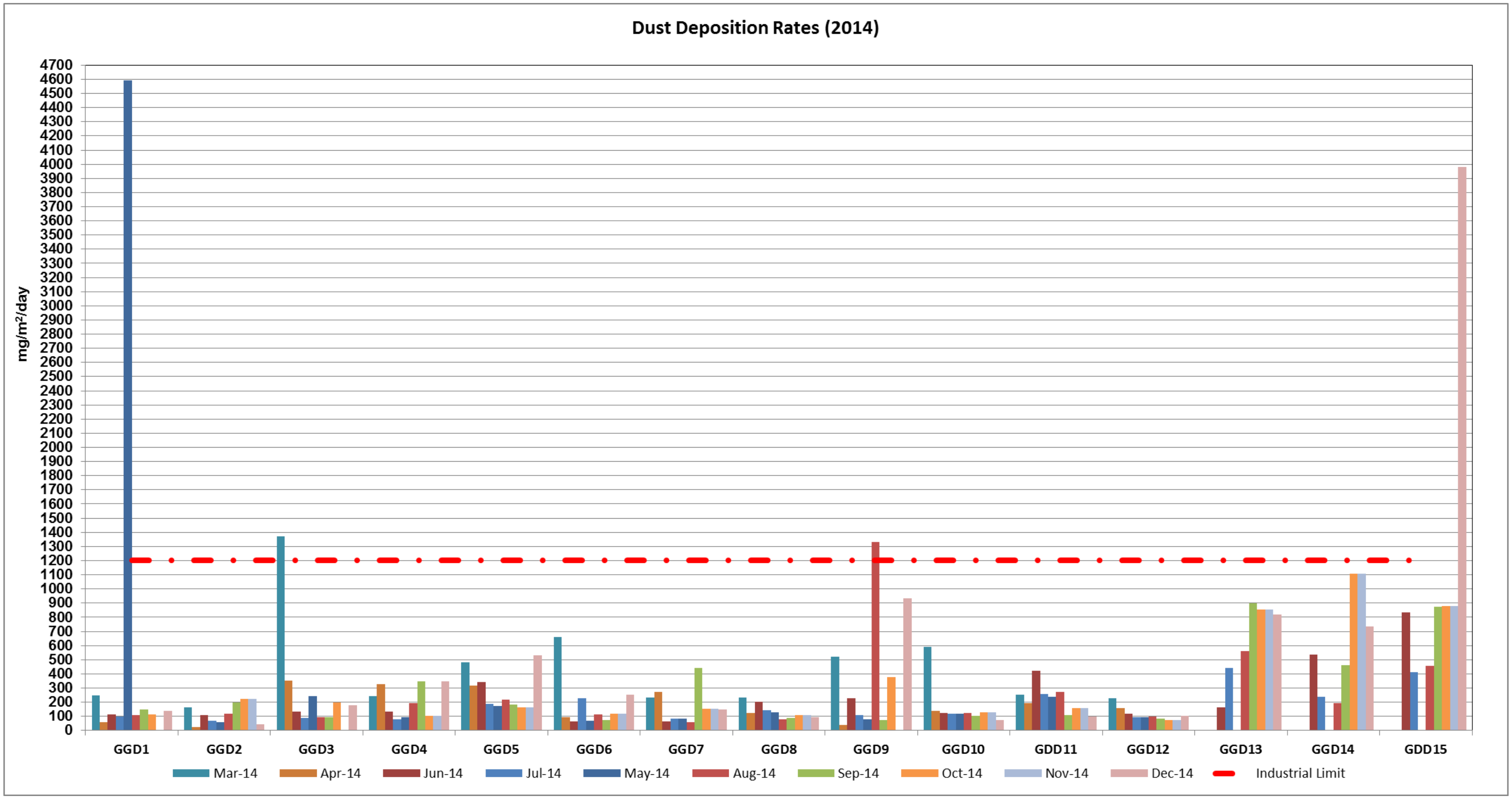

Figure 5-9: Baseline dust deposition rates in the vicinity of the Grootegeluk Mine

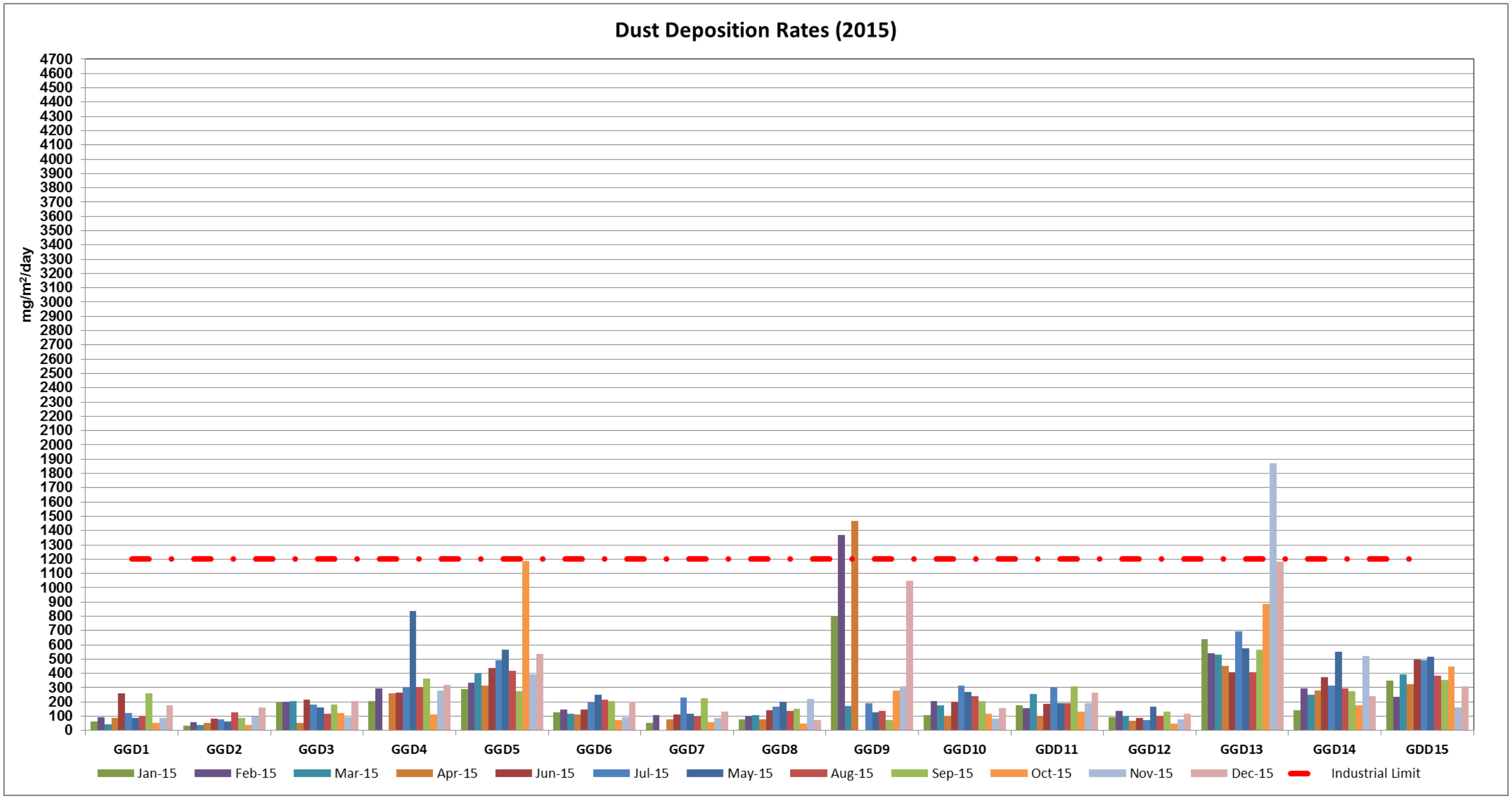

Figure 5-10: Baseline dust deposition rates in the vicinity of Grootegeluk Mine

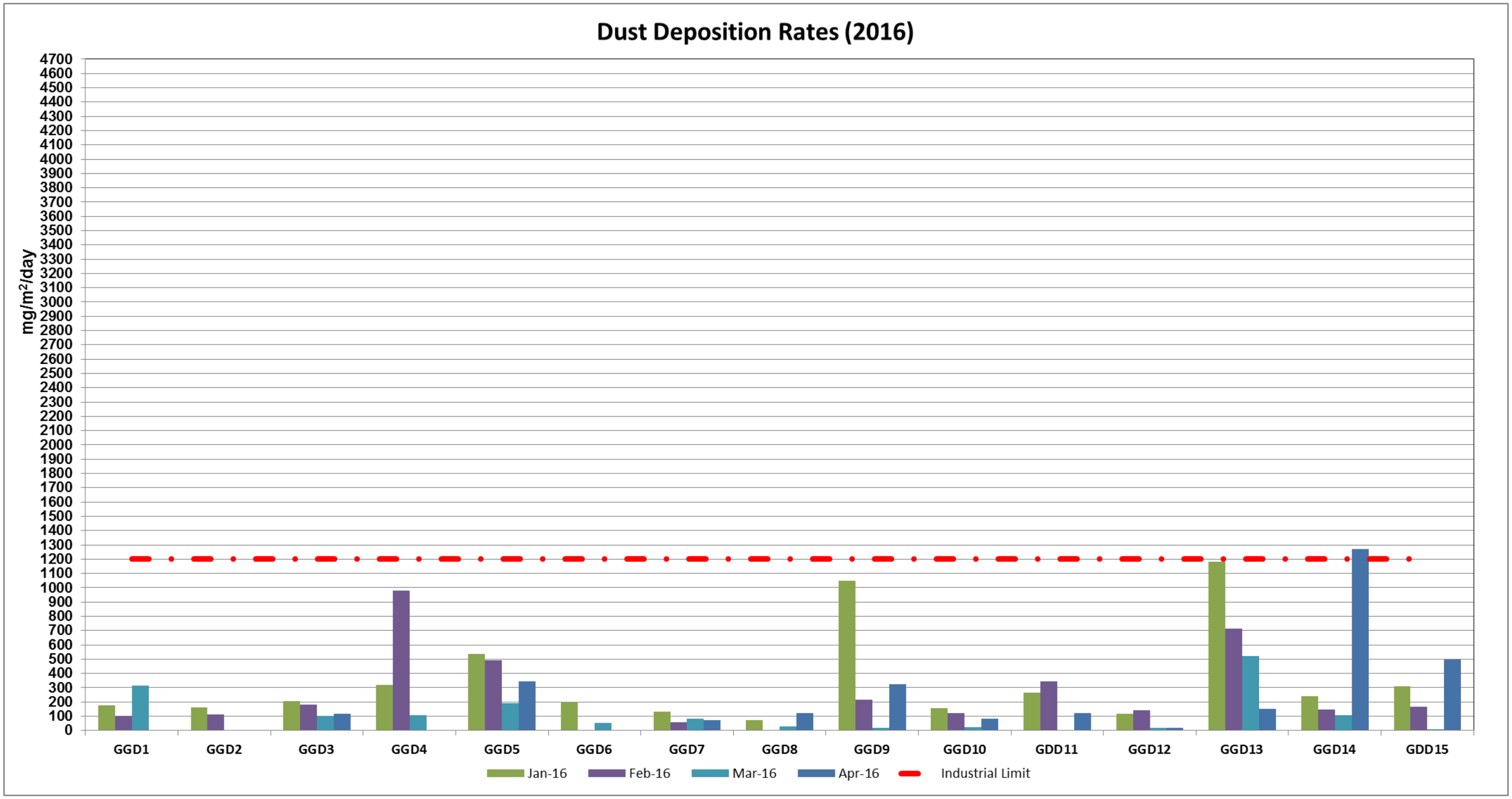

Figure 5-11: Baseline dust deposition rates in the vicinity of Grootegeluk Mine

5.2.1.1 Measured Dust Fallout Levels

Measured results are presented and compared against the current NDCR 2013 standard. The deposition rates observed confirm that the area is generally within compliance despite the exceedances observed, since the aforementioned did not occur in consecutive months. The measured deposition rates compared to the recommended standards are shown in Figure 5-9, Figure 5-10 and Figure 5-11. However, sites GGD9 and GGD13 should be investigated due to the high deposition rates observed.

Also, the recommended margin of tolerance was not violated. According to the standard, the margin of tolerance is *two times within a year*, *not sequential months*. All the sites were within compliance for the period under survey.

5.2.2 Fine Particulate Matter

Ambient air quality data from the Waterberg Bojanala Priority Area monitoring station in Lephalale (23˚40'77.72", 27 ˚43'19.53") owned by the Departmental of Environmental Affairs (DEA) and hosted by South African Air Quality Information System (SAAQIS) was used to assess background air quality scenario in the area for PM_{10} and $PM_{2.5}$ for the period 2012 to June 2016. PM_{10} and $PM_{2.5}$ data from the station are discussed.

5.2.2.1 Background PM_{10} Data (SAAQIS)

Figure 5-12 shows the PM_{10} levels from the Lephalale station for the period 2012 to 2016. Exceedance of the daily limit of 75 µg/m^3 during the monitoring period were observed in October 2012, May and August 2013. In general, the ambient concentrations of PM_{10} are lower during the summer months.

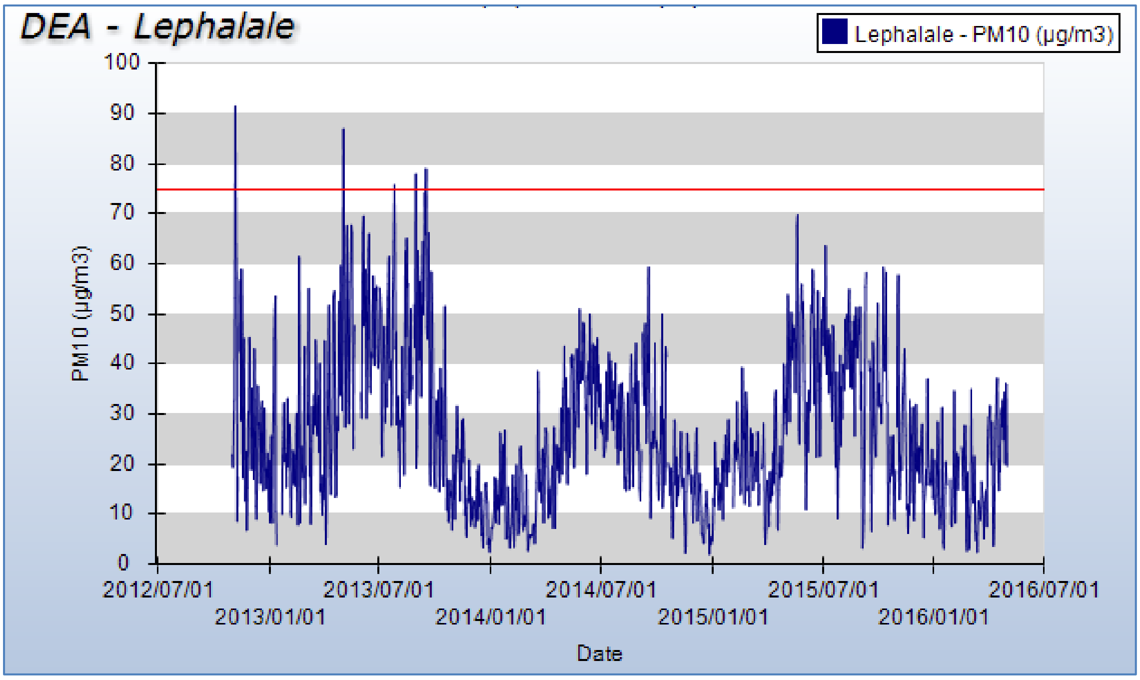

Figure 5-12: Daily PM_{10} averages (SAAQIS, 2016)

5.2.2.2 Background $PM_{2.5}$ Data (SAAQIS)

The daily $PM_{2.5}$ concentrations at the ambient monitoring station are depicted in Figure 5-13 for the period from 2012 to 2016. The highest $PM_{2.5}$ daily levels were experienced in September 2013, September 2014 with the lowest $PM_{2.5}$ levels in from January to March from 2013 to 2016. The red line was the previous standard, which could not be removed as the figure was generated from the SAAQIS website. Concentrations are below the current standard of 40 µgm^{-3}.

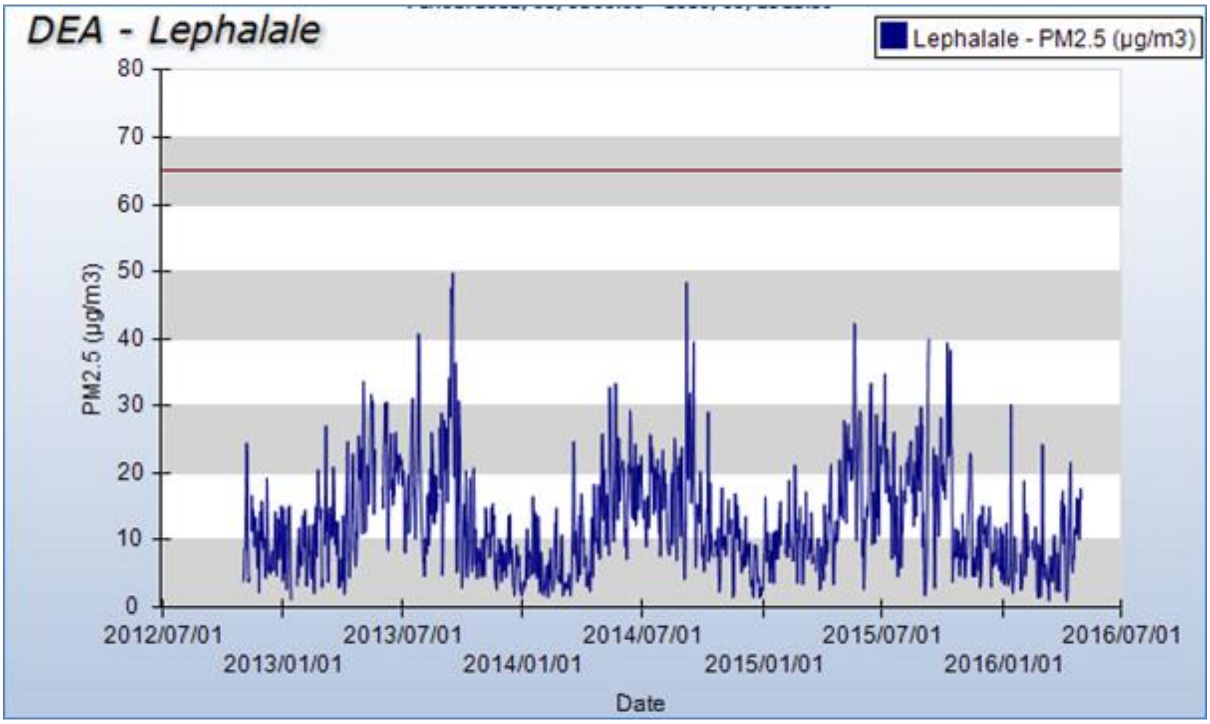

Figure 5-13: Daily $PM_{2.5}$ averages (SAAQIS, 2016)

6 LEGAL CONTEXT

Guidelines provide a basis for protecting public health from adverse effects of air pollution and for eliminating, or reducing to a minimum, those contaminants in air that are known or likely to be hazardous to human health and wellbeing (World Health Organization, 2000). Once the guidelines are adopted as standards, they become legally enforceable. These standards prescribe the allowable ambient concentrations of pollutants which are not to be exceeded during a specified time period in a defined area. If the air quality guidelines/standards are exceeded, the ambient air quality is poor and the potential for health effects is greatest.

The prevailing legislation in the Republic of South Africa with regards to the air quality field is the National Environment Management: Air Quality Act (Act No. 39 of 2004) (NEM: AQA). The NEM: AQA repealed the Atmospheric Pollution Prevention Act (45 of 1965) (APPA).

According to NEM: AQA, the Department of Environmental Affairs (DEA), the provincial environmental departments and local authorities (district and local municipalities) are separately and jointly responsible for the implementation and enforcement of various aspects of NEM: AQA. Each of these spheres of government is obliged to appoint an air quality officer and to co-operate with each other and co-ordinate their activities through mechanisms provided for in the National Environment Management Act, 1998 (Act 107 of 1998) (NEMA).

The purpose of NEM: AQA is to set norms and standards that relate to:

- Institutional frameworks, roles and responsibilities;
- Air quality management planning;
- Air quality monitoring and information management;
- Air quality management measures; and
- General compliance and enforcement.

Amongst other things, it is intended that the setting of norms and standards will achieve the following:

- The protection, restoration and enhancement of air quality in South Africa;
- Increased public participation in the protection of air quality and improved public access to relevant and meaningful information about air quality; and
- The reduction of risks to human health and the prevention of the degradation of air quality.

A fundamental aspect of the new approach to the air quality regulation, as reflected in the NEM: AQA, is the establishment of National Ambient Air Quality Standards (NAAQS). The NEM: AQA provides for the identification of priority pollutants and the setting of ambient standards with respect to these pollutants.

DEA has established the National Ambient Air Quality Standards for the criteria pollutants in the Government Notice - GN1210:2009 (Table 6-1). Table 6-1 gives an overview of the established NAAQS, as well reference methods and compliance dates for criteria pollutants.

Table 6-1: National Ambient Air Quality Standards as of 24 December 2009.

National Ambient Air Quality Standard for Sulphur Dioxide (SO_2)

AVERAGING PERIOD	LIMIT VALUE (µg/m^3)	LIMIT VALUE (ppb)	FREQUENCY OF EXCEEDANCE	COMPLIANCE DATE
10 Minutes	500	191	526	Immediate
1 hour	350	134	88	Immediate
24 hours	125	48	4	Immediate
1 year	50	19	0	Immediate

The reference method for the analysis of SO_2 shall be ISO 6767.

National Ambient Air Quality Standard for Nitrogen Dioxide (NO_2)

AVERAGING PERIOD	LIMIT VALUE (µg/m^3)	LIMIT VALUE (ppb)	FREQUENCY OF EXCEEDANCE	COMPLIANCE DATE
1 hour	200	106	88	Immediate
1 year	40	21	0	Immediate

The reference method for the analysis of NO_2 shall be ISO 7996.

National Ambient Air Quality Standard for Particulate Matter (PM_{10})

AVERAGING PERIOD	LIMIT VALUE (µg/m^3)	FREQUENCY OF EXCEEDANCE	COMPLIANCE DATE
24 hour	75	4	1 January 2015
1 year	40	0	1 January 2015

The reference method for the determination of the PM_{10} fraction of suspended particulate matter shall be EN 12341.

National Ambient Air Quality Standard for Ozone (O_3)

AVERAGING PERIOD	LIMIT VALUE (µg/m^3)	LIMIT VALUE (ppb)	FREQUENCY OF EXCEEDANCE	COMPLIANCE DATE
8 hours (running)	120	61	11	Immediate

The reference method for the analysis of ozone shall be the UV photometric method as described in SANS 13964.

National Ambient Air Quality Standard for Benzene (C_6H_6)

AVERAGING PERIOD	LIMIT VALUE (µg/m^3)	LIMIT VALUE (ppb)	FREQUENCY OF EXCEEDANCE	COMPLIANCE DATE
1 year	5	1.6	0	1 January 2015

The reference methods for the sampling and analysis of benzene shall either be EPA compendium method TO-14 A or method TO-17.

National Ambient Air Quality Standard for Lead (Pb)

AVERAGING PERIOD	LIMIT VALUE (µg/m^3)	LIMIT VALUE (ppb)	FREQUENCY OF EXCEEDANCE	COMPLIANCE DATE

1 year	0.5		0	Immediate
The reference method for the analysis of lead shall be ISO 9855.				

National Ambient Air Quality Standard for Carbon Monoxide (CO)				
AVERAGING PERIOD	**LIMIT VALUE (mg/m^3)**	**LIMIT VALUE (ppm)**	**FREQUENCY OF EXCEEDANCE**	**COMPLIANCE DATE**
1 hour	30	26	88	Immediate
8 hour (calculated on 1 hourly averages)	10	8.7	11	Immediate
The reference method for analysis of CO shall be ISO 4224.				

The Minister of Water and Environmental Affairs, in terms of section 9 (1) of the NEM: AQA established the National Ambient Air Quality Standard for particulate matter of aerodynamic diameter less than 2.5 micron metre ($PM_{2.5}$), published in GN R 486 in GG 35463 of 29 June 2012 (Table 6-2).

Table 6-2: National Ambient Air Quality Standard for Particulate Matter $PM_{2.5}$

National Ambient Air Quality Standard for Particulate Matter ($PM_{2.5}$)			
AVERAGING PERIOD	**CONCENTRATION**	**FREQUENCY OF EXCEEDANCE**	**COMPLIANCE DATE**
24 hours	40 $\mu g/m^3$	4	1 January 2016 – 31 December 2029
24 hours	25 $\mu g/m^3$	4	1 January 2030
1 year	20 $\mu g/m^3$	0	1 January 2016 – 31 December 2029
1 year	15 $\mu g/m^3$	0	1 January 2030
The reference method for the determination of the $PM_{2.5}$ fraction of suspended particulate matter shall be EN 14907.			

In line with NEM: AQA, the National Department of Environmental Affairs has published the National Dust Control Regulations in Government Notice 827 in Gazette 36974 on 1 November 2013.

Terms like target, action and alert thresholds were omitted. Another notable observation was the reduction of the permissible frequency from three to two incidences within a year. The standard actually adopted a more stringent approach than previously, and will require dedicated mitigation plans once it is in force.

The National Dust fallout standard is given in the Table 6-3 below.

Table 6-3: Acceptable dust fall rates (using ASTM D1739:1970 or equivalent).

Restriction Areas	Dust fall rate (mg/m^2/day, 30-days average)	Permitted Frequency of exceeding dust fall rate
Residential Area	D < 600	Two within a year, not sequential months
Non-Residential Area	600 < D < 1200	Two within a year, not sequential months

7 HEALTH EFFECTS OF THE IDENTIFIED POLLUTANTS

7.1 Particulates

The main pollutants of concern identified as a result of the construction and operational of the proposed infrastructure will be particulate matter, whether in the form of total suspended particulates (TSP), PM_{10} or $PM_{2.5}$.

Particles can be classified by their aerodynamic properties into coarse particles, PM_{10} (particulate matter with an aerodynamic diameter of less than 10 μm) and fine particles, $PM_{2.5}$ (particulate matter with an aerodynamic diameter of less than 2.5 μm) (Harrison and van Grieken, 1998). The fine particles contain the secondarily formed aerosols such as sulphates and nitrates, combustion particles and recondensed organic and metal vapours. The coarse particles contain earth crust materials and fugitive dust from roads and industries (Fenger, 2002).

In terms of health effects, particulate air pollution is associated with complaints of the respiratory system (WHO, 2000). Particle size is important for health because it controls where in the respiratory system a given particle deposits. Fine particles are thought to be more damaging to human health than coarse particles as larger particles are less respirable in that they do not penetrate deep into the lungs compared to smaller particles (Manahan, 1991). Larger particles are deposited into the extrathoracic part of the respiratory tract while smaller particles are deposited into the smaller airways leading to the respiratory bronchioles (WHO, 2000).

PM is a type of air pollution that is present wherever people live. It is generated mainly by human activities: transport, energy production, domestic fuel combustion and by a wide range of industries. There is no evidence of a safe level of exposure or a threshold below which no adverse health effects occur.

The range of adverse health effects of PM is broad, involving respiratory and cardiovascular systems in children and adults. Both short and long-term exposures lead to adverse health effects. Very young children, probably including unborn babies, are particularly sensitive to the adverse effects of PM. The evidence is sufficient to infer a causal relationship between exposure to PM and deaths from respiratory diseases in the post-neonatal period. Adverse effects of PM on lung development include reversible deficits of lung function as well as chronically reduced lung growth rate and long-term lung function deficit. The available evidence is also sufficient to assume a causal relationship between exposure to PM and aggravation of asthma, as well as cough and bronchitis symptoms. Daily mortality and hospital admissions have been linked with short term variation of PM levels. Increased mortality from cardiovascular and respiratory diseases and from lung cancer has been observed in residents of more polluted areas.

Existing evidence of adverse health effects at low levels of exposure prompted WHO to revise its Air Quality Guidelines (AQG) for particulate matter in 2005. For $PM_{2.5}$, the AQG values are 10 µg/m^3 for the annual average and 25 µg/m^3 for the 24-hour average (not to be exceeded for more than 3 days/year). The corresponding guidelines for PM_{10} were set as 20 µg/m^3 (annual) and 50 µg/m^3 (daily).

Ambient PM_{10} concentrations are a good approximation of population exposure to PM from outdoor sources. Numerous epidemiological studies conducted in Europe and in other parts of the world have shown adverse health effects of exposure to PM_{10} and $PM_{2.5}$ at concentrations that are currently observed in Europe and the rest of the world. WHO estimated that approximately 700 annual deaths from acute respiratory infections in children aged 0–4 years could be attributed to PM_{10} exposure in the WHO European Region in the late 1990s alone. Population health effects of exposure to PM in adults are dominated by mortality associated with long-time exposure to fine PM ($PM_{2.5}$). Short-term and long-term health effects associated with exposure to particulate matter are presented in Table 7-1.

7.1.1 Short-term exposure

Recent studies suggest that short-term exposure to particulate matter is associated with health effects, even at low concentrations of exposure. Various studies undertaken during the 1980s and early 1990s have looked at the relationship between daily fluctuations in particulate matter and mortality at low levels of exposure. Pope *et al* (1992) studied daily mortality in relation to PM_{10} concentrations in Utah Valley during the period 1985 - 1989. A maximum daily average concentration of 365 µg/m^3 was recorded with effects on mortality observed at concentrations of < 100 µg/m^3. The increase in total daily mortality was 13% per 100 µg/m^3 increase in the 24 hour average. Studies by Schwartz (1993) in Birmingham recorded daily concentrations of 163 µg/m^{3}and noted that an increase in daily mortality was experienced with an increase in PM_{10} concentrations. Relative risks for chronic lung disease and cardiovascular deaths were higher than deaths from other causes.

However, in the past, daily particulate concentrations were in the range 100 – 1000 µg/m^3 whereas in more recent times, daily concentrations are between 10 – 100 µg/m^3. Overall, exposure-response can be described as curvilinear, with small absolute changes in exposure at the low end of the curve having similar effects on mortality to large absolute changes at the high end (WHO, 2000).

Morbidity effects associated with short-term exposure to particulates include increases in lower respiratory symptoms, medication use and small reductions in lung function. Pope and Dockery (1992) studied panels of children in Utah Valley in winter during the period 1990 – 1991. Daily PM_{10} concentrations ranged between 7 – 251 µg/m^3. Peak Expiratory Flow was decreased and respiratory symptoms increased when PM_{10} concentrations increased. Pope and Kanner (1993) utilised lung function data obtained from smokers with mild to moderate chronic obstructive pulmonary disease in Salt Lake City. The estimated effect was a 2% decline in Forced Expiratory Volume over one second for each 100 µg/m^3 increase in the daily PM_{10} average.

7.1.2 Long-term exposure

Long-term exposure to low concentrations (~10 µg/m^3) of particulates is associated with mortality and other chronic effects such as increased rates of bronchitis and reduced lung function (WHO, 2000).The short term and long term effects associated with particulate matter are depicted in Table 7-1.

Studies have indicated an association between lung function and chronic respiratory disease and airborne particles. Older studies by Chestnut *et al* (1991) found that Forced Vital Capacity decreases with increasing annual average particulate levels with an apparent threshold at 60 µg/m^3. Using chronic respiratory disease data, Schwartz (1993) determined that the risk of chronic bronchitis increased with increasing particulate concentrations, with no apparent threshold.

Few studies have been undertaken documenting the morbidity effects of long-term exposure to particulates. Recently, the Harvard Six Cities Study showed increased respiratory illness rates among children exposed to increasing particulate, sulphate and hydrogen ion concentrations. Relative risk estimates suggest an 11% increase in cough and bronchitis rates for each 10 µg/m^3 increase in annual average particulate concentrations.

Table 7-1: Short-term and long-term health effects associated with exposure to PM (WHO, 2004).

Pollutant	Short-term exposure	Long-term exposure
Particulate matter	■ Lung inflammatory reactions ■ Respiratory symptoms ■ Adverse effects on the cardiovascular system ■ Increase in medication usage ■ Increase in hospital admissions ■ Increase in mortality	■ Increase in lower respiratory symptoms ■ Reduction in lung function in children ■ Increase in chronic obstructive pulmonary disease ■ Reduction in lung function in adults ■ Reduction in life expectancy ■ Reduction in lung function development

8 METHODOLOGY AND RESULTS

8.1 Emissions Inventory

The development of an emissions inventory forms the basis for any air quality impact assessment. Air pollution emissions may typically be obtained using actual sampling at the point of emission, or estimating it from mass and energy balances or emission factors which have been established at other, similar operations. The method adopted here is the latter. Emission factors published by the US-EPA in its AP-42 document Compilation of Air Pollution Emission Factors and Australian National Pollutant Inventory Emission Estimation Technique Manuals (Common Wealth Australia 2012) were utilised.

There are various sources of emissions anticipated from the existing coal mine i.e. operational phase. Typical emissions from the coal mine include:

- Inhalable particulates, with aerodynamic diameters less than or equal to 10 micron (PM_{10}) and $PM_{2.5}$ from all mining sources;
- TSP from all mining sources;
- Gaseous emissions from stationary and mobile combustion engines (which were not quantified in the study).

An emissions inventory was established comprising emissions for the different activities associated with the proposed Grootegeluk stockpile amendments. Pollutants release rate from the emissions inventory served as input parameters for the dispersion model simulations.

8.1.1 Material handling operations

During material handling, the coal is deposited onto the various temporary stockpiles. This coal will be transported via roads on haul trucks to the respective storage facilities. Source emissions vary depending on various factors such as wind speed, wind direction and the moisture content of the coal stockpiles. The higher the moisture content, the less fugitive dust released into the atmosphere. To calculate the emissions from the material handling operations, equations from US EPA AP-42 and Australian NPI emission factors were utilised for loading and tipping operations.

8.1.2 Wind erosion from coal stockpiles

Table 8-1 shows the specifications of the different stockpiles which are potential sources of dust due to wind erosion. Emission rates were calculated based on these parameters.

Table 8-1: Parameters for stockpiles

Source	X length (m)	Y length (m)	Height (m)	Area (ha)

GG10 Stockyard A	900	210	20	18.9
GG 10 Stockyard B	550	300	20	16.5
Laydown area	205	650	20	13.3
Extension area	210	610	20	12.8
Multi product stockpile	102	500	20	5.1

8.1.2.1 Predictive Emission Factors

The State Pollution Control Commission of New South Wales, Australia (SPCC, 1983) published a number of emission factors i.e. the average value for wind erosion from open areas is 0.4 kg/ha/h (3,504 kg/ha/year). It is suggested that this value be adopted as a default in the absence of other information. The same applies to all other activities with inadequate information to assess associated pollution load.

AP-42 (US EPA, 1998) states that 50% of the TSP is emitted as PM_{10}. Therefore, the default emission factor for PM_{10} is 0.2 kg/ha/h. These assertions were considered in the emissions inventory for this study.

Default values:

$$EF_{TSP\,(kg/ha/hr)} = 0.4\,kg/ha/hr$$

$$EF_{PM_{10}\,(kg/ha/hr)} = 0.2\,kg/ha/hr$$

For the fine dust component of particulate emissions from industrial wind erosion, a $PM_{2.5}/PM_{10}$ ratio of 0.15 is recommended. Industrial wind erosion is associated with crushed aggregate materials, such as coal or metallic ore piles. Examples would include open storage piles at mining operations (US EPA, 2006).

Significant emissions can arise due to the mechanical disturbance of granular material from open areas and storage piles. Parameters which have the potential to impact on the rate of emission of fugitive dust include the extent of surface compaction, moisture content, ground cover, the shape of the storage pile, particle size distribution, wind speed and moisture content. Any factor that binds the erodible material, or otherwise reduces the availability of erodible material on the surface, decreases the erosion potential of the fugitive source. High moisture content, whether due to precipitation or deliberate wetting, promotes the aggregation and cementation of fines to the surfaces of larger particles, thus decreasing the potential for dust emissions. Surface compaction and ground cover similarly reduces the potential for dust generation. The shape of a storage pile influences the potential for dust emissions through the alteration of the airflow field. The particle size distribution of the material on the disposal site is important since it determines the rate of entrainment of material from the surface, the nature of dispersion of the dust plume, and the rate of deposition which may be anticipated.

Dust emissions due to the erosion of open storage piles and exposed areas occur when the threshold wind speed is exceeded (Cowherd *et al.*, 1988; USEPA, 1995). The threshold wind speed is dependent on the erosion potential of the exposed surface, which is expressed in terms of the availability of erodible material per unit area (mass/area). Studies have shown that when the threshold wind speeds are exceeded, particulate emission rates tend to decay rapidly due to the reduced availability of erodible material (Cowherd *et al.*, 1988).

Fugitive dust generation resulting from wind erosion under high winds (i.e. > 5.4 m/s) is directly proportional to the elevated dust levels. Wind speeds of 5.4 m/s and stronger occur in the Project area for some 5.2% of the time. Average wind speed of 3.0 m/s was calculated from the modelled data.

8.2 Emissions Values

The following are the emission rates utilised in the dispersion modelling simulation conducted with AERMOD. The stockpiles were categorised as area sources (Table 8-2) while material transfer loading onto the various stockpiles were categorised as volume sources (Table 8-3).

Table 8-2: Area source emission rates

Area sources	Emission rate ($g/m^2/s$)		
	TSP	PM_{10}	$PM_{2.5}$
GG10 Stockyard A	1.1E-05	5.5E-06	8.3E-07
GG 10 Stockyard B	1.1E-05	5.5E-06	8.3E-07
Laydown area	1.1E-05	5.5E-06	8.3E-07
Extension area	1.1E-05	5.5E-06	8.3E-07
Multi product stockpile	1.1E-05	5.5E-06	8.3E-07

Table 8-3: Volume source emission rates

Volume sources	Emission rate (g/s)		
	TSP	PM_{10}	$PM_{2.5}$
Material transfer to GG10 Stockyard A	5.22E-02	2.47E-02	3.74E-03
Material transfer to GG 10 Stockyard B	5.22E-02	2.47E-02	3.74E-03
Material transfer to laydown area	5.22E-02	2.47E-02	3.74E-03
Material transfer to extension area	5.22E-02	2.47E-02	3.74E-03

Material transfer to multi product stockpile	5.22E-02	2.47E-02	3.74E-03

8.3 Particle Size Distribution

Wind erosion is generally a selective material-loss process, which moves particles of various size fractions at different mass-flow rates; one also needs to understand how the particle-size distribution (PSD) is related to material properties. PSD is a key parameter determining the entire process of wind erosion, from entrainment through transport to deposition. The particle size distribution of coal provided by the client is depicted below (

Table 8-4).

Table 8-4: Particle size distribution for coal

Typical Analysis	
Characteristic	**Value (%)**
1000 µm	2.76
850µm	2.84
600µm	17.92
500µm	14.41
300µm	20.84
150µm	21.58
106µm	8.07
75µm	4.78
-75µm	6.80
	100.00

9 Dispersion Modelling

The modelled scenario in this project involves the expansion of various stockpiles as shown in the infrastructure setting (Figure 1-1). It is assumed that the mine operates for 24 hours per day and 365 days a year. The pollutants modelled were PM_{10}, $PM_{2.5}$ and TSP. For TSP, two scenarios were modelled, deposition without mitigation and deposition with mitigation.

Dispersion models are used to predict the ambient concentration in the air of pollutants emitted to the atmosphere from a variety of processes (South African National Standards - SANS 1929:2011). Dispersion models compute ambient concentrations as a function of source configurations, emission strengths and meteorological characteristics, thus providing a useful tool to ascertain the spatial and temporal patterns in the ground level concentrations arising from the emissions of various sources. Increasing reliance has been placed on concentration estimates from models as the primary basis for environmental and health impact assessments, risk assessments and emission control requirements. It is therefore important to carefully select a dispersion model for the purpose.

All emission scenarios have been simulated using the United States Environmental Protection Agency's Preferred/Recommended Models: AERMOD modelling system (as of December 9, 2006, AERMOD is fully promulgated as a replacement to ISC3 model).

The AERMOD modelling system incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain.

There are two input data processors that are regulatory components of the AERMOD modelling system: AERMET, a meteorological data pre-processor that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, and AERMAP, a terrain data pre-processor that incorporates complex terrain using USGS Digital Elevation Data. Other non-regulatory components of this system include: AERSCREEN, a screening version of AERMOD; AERSURFACE, a surface characteristics pre-processor, and BPIPPRIME, a multi-building dimensions program incorporating the GEP technical procedures for PRIME applications.

AERMOD model is capable of providing ground level concentration estimates of various averaging times, for any number of meteorological and emission source configurations (point, area and volume sources for gaseous or particulate emissions), as well dust deposition estimates.

The effect of complex terrain is modelled by changing the plume trajectory and dispersion to account for disturbances in the air flow due to the terrain. This may increase or decrease the concentrations calculated. The influence of the terrain will vary with the source height and position and the local meteorology. The terrain used in the model is elevated.

9.1 Modelled Domain

A square receptor grid of 20 km x 20 km was utilised as the modelling domain. The multi-tier grid mesh was utilised. Multi-tier grid combines coarse and fine grids to ensure that maximum impacts from sources are captured. Table 9-1 shows the grid spacing utilised dispersion model simulations.

Table 9-1: Grid spacing for receptor grids.

Tier	Distance from centre (m)	Tier spacing (m)
1	1000	100
2	5000	250
3	10000	500

A total of 3 281 grid points were generated. Each of the grid points has x and y (Cartesian co-ordinates) values in metres. Terrain effects were imported from NASA Shuttle Radar Topography Mission (SRTM3) global database with ~90 m accuracy and processed by the AERMAP module of AERMOD.

This receptor grid has been chosen to include the nearest sensitive receptors (these are mainly surrounding farms and residential dwellings and to provide an indication of the extent of impact. The 24 hour and annual averaging times have been used for consistency. The modelling has been performed using the modelled meteorological data and rates derived from the emissions inventory.

Table 9-2 gives an overview of meteorological parameters and basic setup options for the AERMOD model runs.

Table 9-2: Summary of meteorological and AERMET parameters used in the dispersion model

Years of analysis	Jan 2013 to Dec 2015
Centre of analysis	23.65895 S, 27.55672 E
Meteorological grid domain	12 km (east-west) x 12 km (south-north)
Meteorological grid cell resolution	20 km x 20 km
Station Base Elevation	925 mamsl
MM5-Processed Grid Cell (Grid Cell Centre)	23.65895 S, 27.55672 E
Anemometer Height	14 m
Surface meteorological stations	1 site at the Grootegeluk operations using data generated by AERMET
Upper air meteorological stations	1 site at the Grootegeluk operations using data generated by AERMET

Simulation length	26280 hours
Sectors	The surrounding area land use type was considered to be *grassland and residential*

9.2 Sensitive Receptors

Discrete receptors were identified as the houses located around and within the 20 km by 20 km dispersion modelling domain (Table 9-3). The level of exposure to each of the pollutants is dependent on the proximity of the identified receptors to the mine operations, which can intensify if receptor is downwind.

Table 9-3: Identified sensitive receptor locations

Receptor description	Receptor number for air quality modelling	UTM Easting coordinate (m)	UTM Northing coordinate (m)
Marapong community	1	562932.1	7383617
Matimba Power Station	2	562400.2	7382332
Medupi Power Station	3	557270.9	7378634
Van Der Waltspan 310 LQ	5	549102	7388116
Buffelsjagt 317 LQ	6	546837	7375437
Droogeheuvel 447 LQ	7	564885	7388140

9.3 Assessment of Impacts

The AERMOD model predicts the one-hour average concentration at each receptor grid point specified, for each hour of the year's meteorological data. The highest ground level concentration is established for each hour and is referred to as the peak hourly concentration.

The daily values option controls the output options for tables of concurrent values summarised by receptor for each day processed. For each averaging period for which the daily values option is selected, the model will print in the main output file the concurrent averages for all receptors for each day of data processed. Results are output for each source group.

The ground level concentration of pollutants follow closely the main wind directions Numerical values of maximum depend on the emission rate and the meteorological data used. Simulations were undertaken to determine the concentrations of PM_{10}, $PM_{2.5}$, and dust (TSP) from sources associated with the proposed amendment at the Grootegeluk mine.

9.3.1 Isopleth Plots and Evaluation of Modelling Results

A summary of ground level concentrations predicted at the mine boundary for the different pollutants are presented in Table 9-4.

Table 9-4: South African ambient air quality standards versus predicted concentrations at the mine boundary.

Pollutant	Averaging period	Guideline (µg/m³)	Ground level concentrations at the mine boundary?	Figure
	Unmitigated concentrations			
PM_{10}	24 Hours	75 [1]	10.2	9-16
	1 Year	40[1]	0.9	9-17
$PM_{2.5}$	24 Hours	40[1]	3	9-18
	1 Year	20[1]	0.3	9-19
Dust deposition	Maximum 24 Hours	600[2]	3	9-20
	Mitigated concentrations			
Dust Deposition	Maximum 24 Hours	600[2]	0.5	9-21

(1) South African- 1 January 2016 National Ambient Air Quality Standards (NAAQS)
(2) South African- National Ambient Air Quality Standards (NAAQS) – National Dust Control Regulation 2013

9.3.2 PM_{10} Predicted Impacts

The isopleth and predicted 24-hour ground concentrations due to wind erosion from the proposed stockpiles and the material handling processes are given in Figure 9-1 and Table 9-5. The predicted highest of 10.2 µg/m³ at the mine boundary is within the current standard of 75 µg/m³. Concentrations at the sensitive receptors are very low and will have negligible impacts on background air quality. The lowest predicted ground level concentrations at the selected sensitive receptors are presented in Table 9-5.

Table 9-5: Predicted 24 hour concentrations at sensitive receptors

Sensitive Receptors	Ground level concentration (µg/m³)
Grootegeluk Mine boundary	10.2
Marapong community	1.7

Sensitive Receptors	Ground level concentration ($\mu g/m^3$)
Matimba Power Station	2.9
Medupi Power Station	4.2
Van Der Waltspan 310 LQ	5.0
Buffelsjagt 317 LQ	4.3
Droogeheuvel 447 LQ	1.7

The highest annual concentration of PM_{10} predicted as a result of wind erosion from the proposed stockpiles of 0.9 $\mu g/m^3$ at the mine boundary is below the current standard of 40 $\mu g/m^3$ (Figure 9-2). Table 9-6 shows the predicted concentrations at the selected sensitive receptors with 0.06 $\mu g/m^3$ and 0.04 $\mu g/m^3$ predicted for Marapong and Droogeheuvel respectively.

Table 9-6: Predicted concentrations at sensitive receptors

Sensitive Receptors	Ground level concentration ($\mu g/m^3$)
Grootegeluk Mine boundary	0.9
Marapong community	0.06
Matimba Power Station	0.08
Medupi Power Station	0.2
Van Der Waltspan 310 LQ	0.24
Buffelsjagt 317 LQ	0.15
Droogeheuvel 447 LQ	0.04

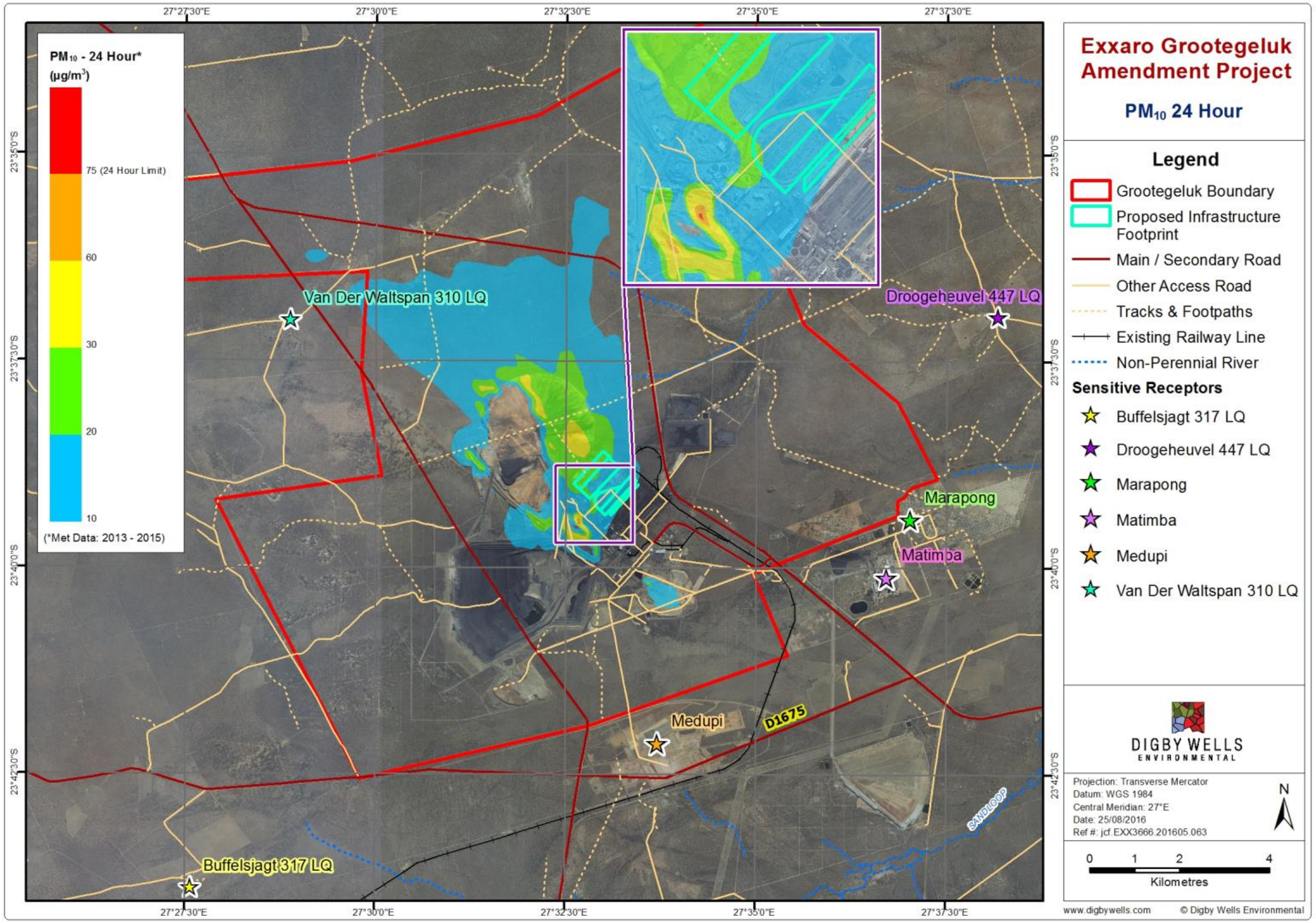

Figure 9-1: Predicted 24-hour average PM_{10} concentrations, 99th percentile ($\mu g/m^3$)

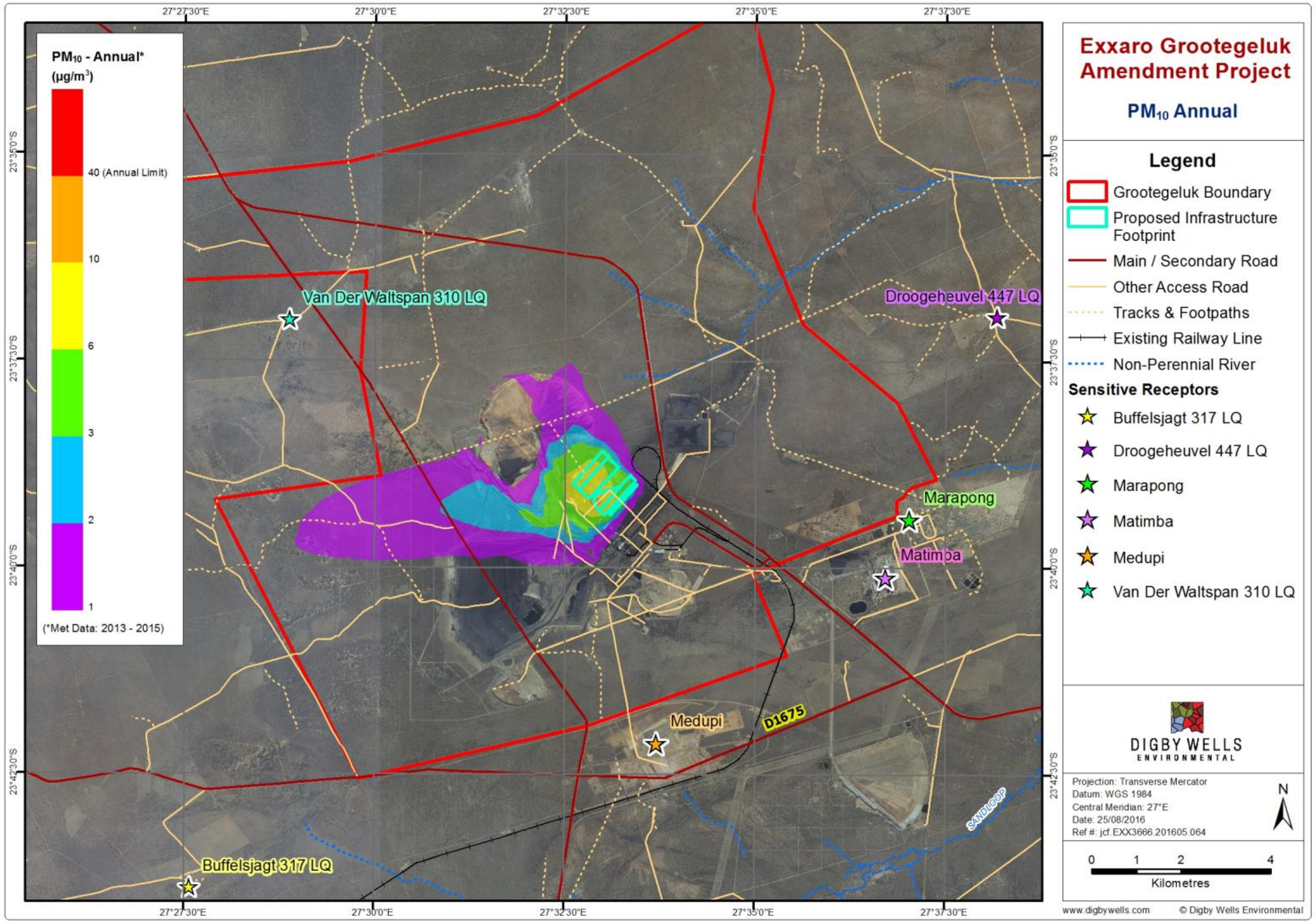

Figure 9-2: Predicted annual average PM_{10} concentrations ($\mu g/m^3$)

9.3.3 $PM_{2.5}$ Predicted Impacts

The isopleth and predicted 24-hour $PM_{2.5}$ ground level concentrations from the stockpiles and the material handling processes are given in Figure 9-3 and Table 9-7. The predicted highest of 3 µg/m³ at the mine boundary is within the current standard of 40 µg/m³. Concentrations at the sensitive receptors are very low and will have negligible impact on background air quality. The lowest predicted ground level concentration at Marapong is 0.6 µg/m³

Table 9-7: Predicted 24 hour average $PM_{2.5}$ concentrations at sensitive receptors

Sensitive Receptors	(µg/m³)
Grootegeluk Mine boundary	3.0
Marapong community	0.6
Matimba Power Station	0.9
Medupi Power Station	1.4
Van Der Waltspan 310 LQ	1.7
Buffelsjagt 317 LQ	1.4
Droogeheuvel 447 LQ	0.9

The predicted highest annual concentration of $PM_{2.5}$ anticipated from the proposed stockpiles is 0.3 µg/m³ at the mine boundary and within the standard of 20 µg/m³ (Figure 9-4). Table 9-6 shows the predicted ground level concentrations at the selected sensitive receptors. Concentrations at the sensitive receptors are very low and will have negligible impact on background air quality. The lowest ground level concentrations are predicted at Marapong, Matimba and Droogeheuvel (Table 9-8).

Table 9-8: Predicted annual average $PM_{2.5}$ concentrations at sensitive receptors

Sensitive Receptors	Ground level concentration (µg/m³)
Grootegeluk Mine boundary	0.30
Marapong community	0.02
Matimba Power Station	0.02
Medupi Power Station	0.06
Van Der Waltspan 310 LQ	0.08
Buffelsjagt 317 LQ	0.05
Droogeheuvel 447 LQ	0.01

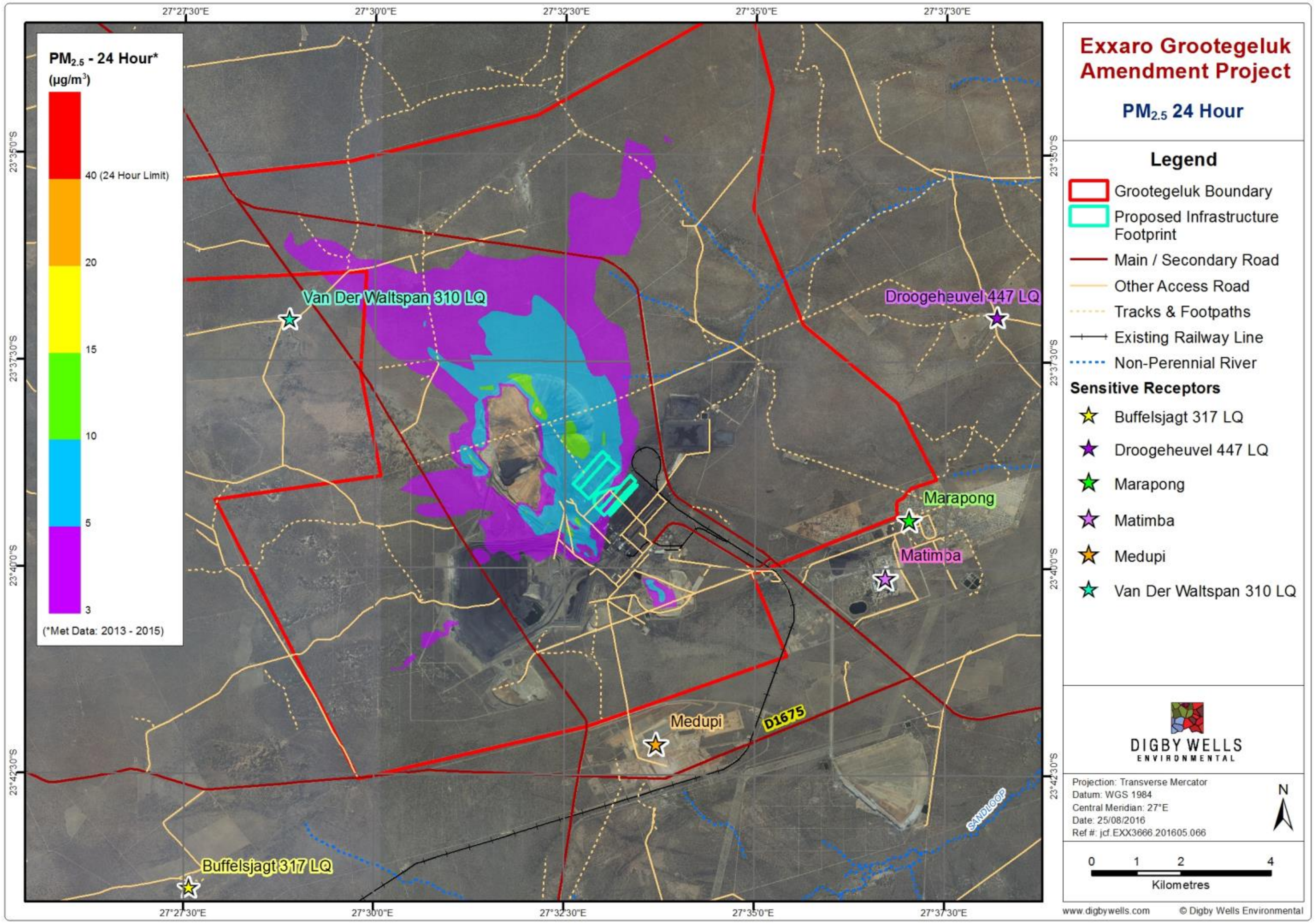

Figure 9-3: Predicted 99th percentile monthly average $PM_{2.5}$ concentrations (µg/m^3)

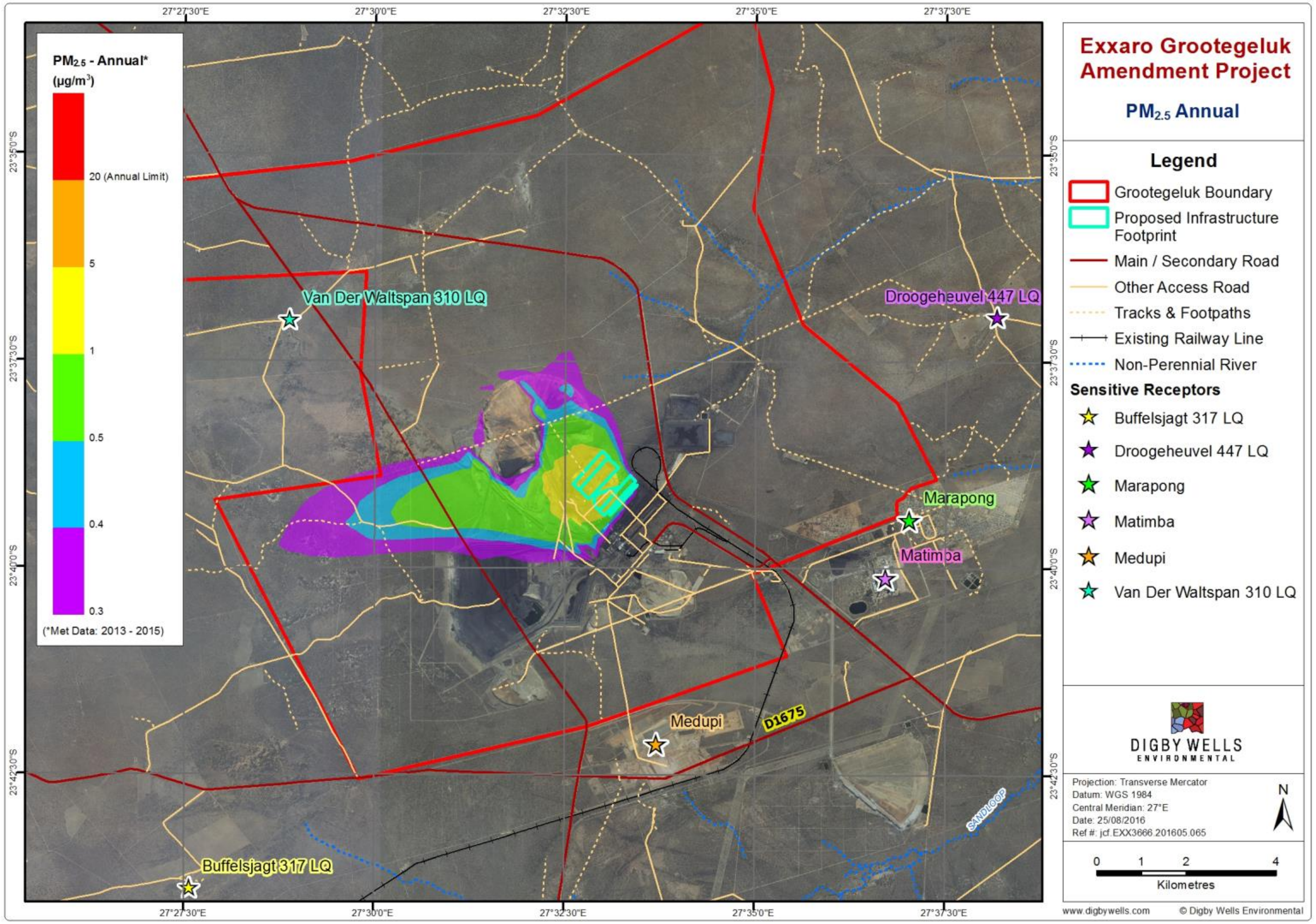

Figure 9-4: Predicted annual average $PM_{2.5}$ concentrations (µg/m^3)

9.3.4 Dust deposition predicted impacts

The maximum dust deposition rate predicted by the model of 352 mg/m²/day at point 555879.00, 7384059 within the mine operations is well within the residential standard (600 mg/m²/day). The highest predicted at the mine boundary of 3 mg/m²/day (Figure 9-5) without mitigation measures will exert negligible impact on background air quality. Dust deposition rates predicted at the sensitive receptors are presented in Table 9-9.

When mitigation measures were applied, the dust deposition maximum deposition rate decreased to 227 mg/m²/day at point 555879.00, 7384059. The predicted dust deposition rates at the sensitive receptor sites are shown in Table 9-9, with the lowest dust deposition rates of 0.3 mg/m²/day and 0.2 mg/m²/day predicted at Van Der Waltspan and Buffelsjagt respectively. Isopleths showing the zones of impact are presented below (Figure 9-5 and Figure 9-6).

Although deposition rates predicted are within the recommended residential limit, mitigation measures should form part of the day to day operation once operation commences.

Table 9-9: Dust deposition rate at sensitive receptors

Receptor point	Dustfall with no mitigation (mg/d/m^2, 30-day average)	Dustfall with mitigation (mg/d/m^2, 30-day average)
NEM:AQA Standard Residential	600	600
NEM:AQA Standard Non-Residential	1 200	1 200
Grootegeluk Mine boundary	3	0.5
Marapong community	0.7	0.5
Matimba Power Station	0.9	0.6
Medupi Power Station	1.1	0.8
Van Der Waltspan 310 LQ	0.8	0.3
Buffelsjagt 317 LQ	0.9	0.3
Droogeheuvel 447 LQ	0.6	0.2

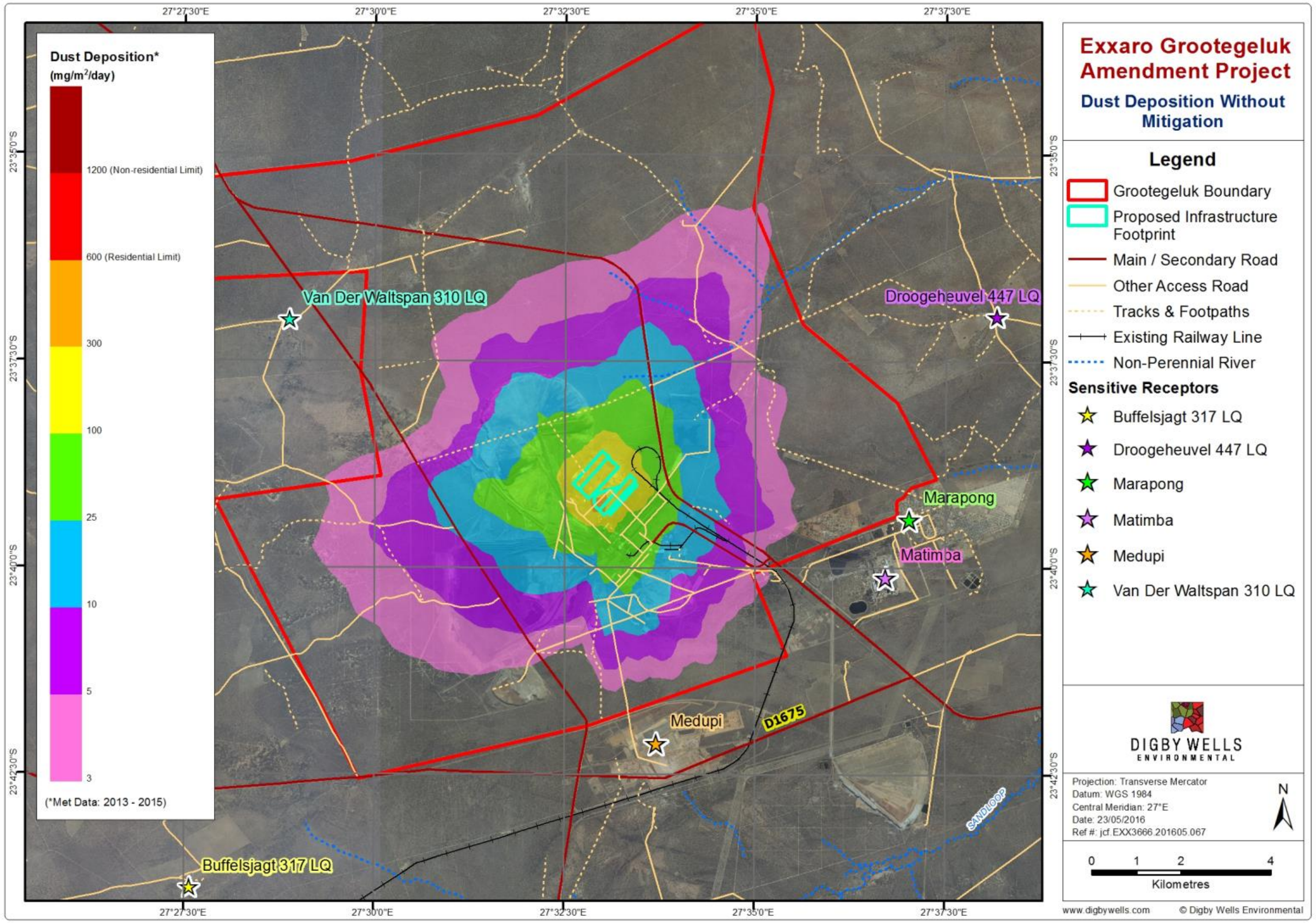

Figure 9-5: Predicted dust fallout average over 30 days ($mg/m^2/d$) no mitigation

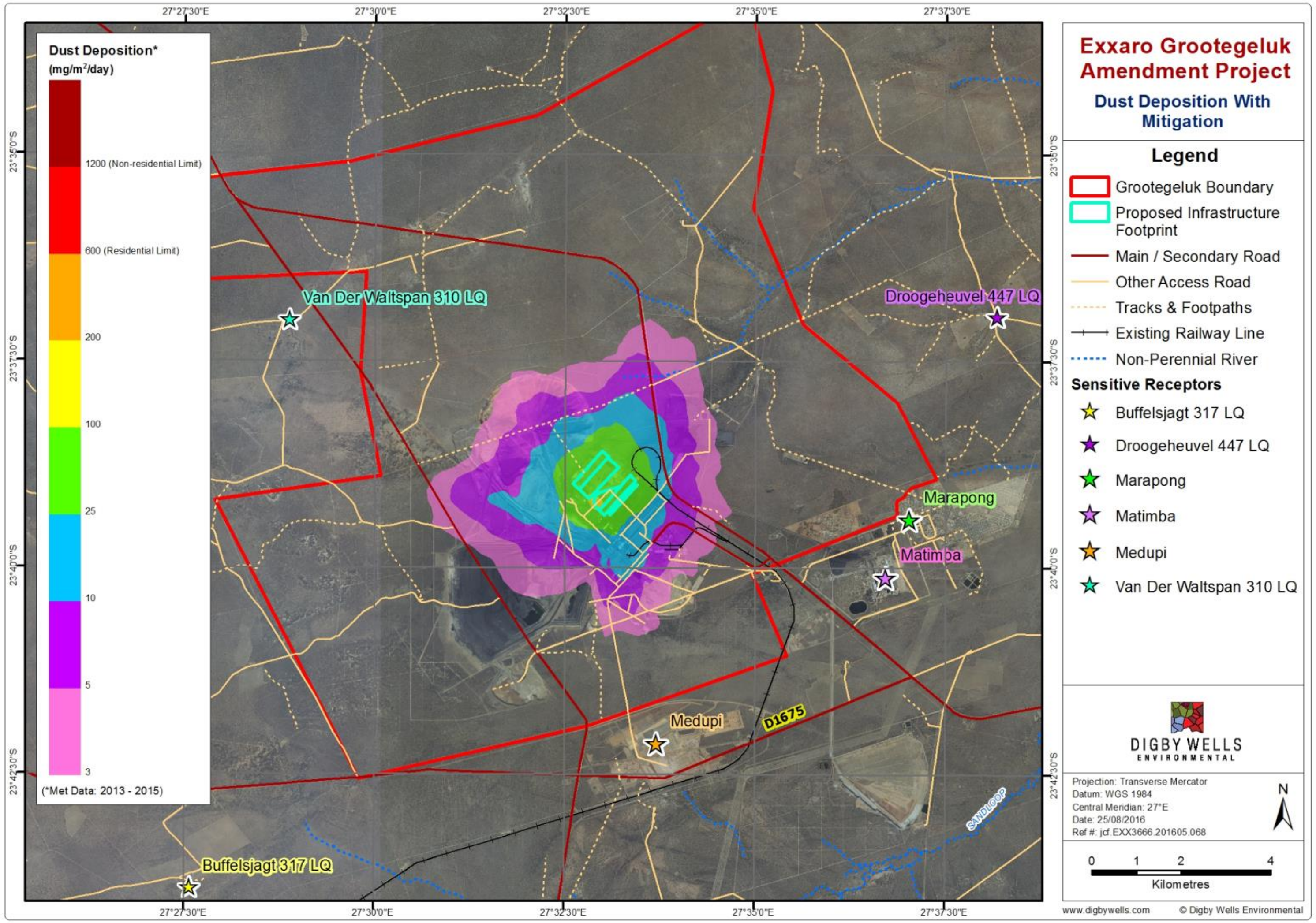

Figure 9-6: Predicted dust fallout average over 30 days (mg/m^2/d) with mitigation

10 IMPACT ASSESSMENT

Based on international guidelines and South African legislation, the following criteria are taken into account when examining potentially significant impacts:

- Nature of impacts (direct/indirect, positive/ negative);
- Duration (short/medium/long-term, permanent(irreversible) / temporary (reversible), frequent/seldom);
- Extent (geographical area, size of affected population/habitat/species);
- Intensity (minimal, severe, replaceable/irreplaceable);
- Probability (high/medium/low probability); and
- Possibility to mitigate, avoid or offset significant adverse impacts.

Details of the impact assessment methodology used to determine the significance of physical, bio-physical and socio-economic impacts are provided below.

The significance rating process follows the established impact/risk assessment formula:

Significance = Consequence x Probability x Nature

Where

Consequence = Intensity + Extent + Duration

And

Probability = Likelihood of an impact occurring

And

Nature = Positive (+1) or negative (-1) impact

Note: In the formula for calculating consequence, the type of impact is multiplied by +1 for positive impacts and -1 for negative impacts.

The matrix calculates the rating out of 147, whereby Intensity, Extent, Duration and Probability are each rated out of seven as indicated in Table 10-1. The weight assigned to the various parameters is then multiplied by +1 for positive and -1 for negative impacts.

Impacts are rated prior to mitigation and again after consideration of the mitigation measure proposed in this Report. The significance of an impact is then determined and categorised into one of eight categories, as indicated in Table 10-2, which is extracted from Table 10-1. The description of the significance ratings is discussed in Table 10-3.

It is important to note that the pre-mitigation rating takes into consideration the activity as proposed, i.e. there may already be certain types of mitigation measures included in the design (for example due to legal requirements). If the potential impact is still considered too high, additional mitigation measures are proposed.

Table 10-1: Impact Assessment Parameter Ratings

RATING	INTENSITY/ REPLACEABILITY		EXTENT	DURATION/REVERSIBILITY	PROBABILITY
	Negative impacts	Positive impacts			
7	Irreplaceable damage to highly valued items of great natural or social significance or complete breakdown of natural and / or social order.	Noticeable, on-going natural and / or social benefits which have improved the overall conditions of the baseline.	International The effect will occur across international borders.	Permanent: The impact is irreversible, even with management, and will remain after the life of the project.	Definite: There are sound scientific reasons to expect that the impact will definitely occur. >80% probability.
6	Irreplaceable damage to highly valued items of natural or social significance or breakdown of natural and / or social order.	Great improvement to the overall conditions of a large percentage of the baseline.	National Will affect the entire country.	Beyond project life: The impact will remain for some time after the life of the project and is potentially irreversible even with management.	Almost certain / Highly probable: It is most likely that the impact will occur. <80% probability.
5	Very serious widespread natural and / or social baseline changes. Irreparable damage to highly valued items.	On-going and widespread benefits to local communities and natural features of the landscape.	Province/ Region Will affect the entire province or region.	Project Life (>15 years): The impact will cease after the operational life span of the project and can be reversed with sufficient management.	Likely: The impact may occur. <65% probability.

RATING	INTENSITY/ REPLACEABILITY		EXTENT	DURATION/REVERSIBILITY	PROBABILITY
	Negative impacts	Positive impacts			
4	On-going serious natural and / or social issues. Significant changes to structures / items of natural or social significance.	Average to intense natural and / or social benefits to some elements of the baseline.	Municipal Area Will affect the whole municipal area.	Long term: 6-15 years and impact can be reversed with management.	Probable: Has occurred here or elsewhere and could therefore occur. <50% probability.
3	On-going natural and / or social issues. Discernible changes to natural or social baseline.	Average, on-going positive benefits, not widespread but felt by some elements of the baseline.	Local Local extending only as far as the development site area.	Medium term: 1-5 years and impact can be reversed with minimal management.	Unlikely: Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur. <25% probability.
2	Minor natural and / or social impacts which are mostly replaceable. Very little change to the baseline.	Low positive impacts experience by a small percentage of the baseline.	Limited Limited to the site and its immediate surroundings.	Short term: Less than 1 year and is reversible.	Rare / improbable: Conceivable, but only in extreme circumstances. The possibility of the impact materialising is very low as a result of design, historic experience or implementation of adequate mitigation measures. <10% probability.
1	Minimal natural and / or social impacts, low-level replaceable damage with no change to the baseline.	Some low-level natural and / or social benefits felt by a very small percentage of the baseline.	Very limited Limited to specific isolated parts of the site.	Immediate: Less than 1 month and is completely reversible without management.	Highly unlikely / None: Expected never to happen. <1% probability.

Table 10-2: Probability/Consequence Matrix

Probability	Significance																																					
7	-147	-140	-133	-126	-119	-112	-105	-98	-91	-84	-77	-70	-63	-56	-49	-42	-35	-28	-21	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140	147
6	-126	-120	-114	-108	-102	-96	-90	-84	-78	-72	-66	-60	-54	-48	-42	-36	-30	-24	-18	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120	126
5	-105	-100	-95	-90	-85	-80	-75	-70	-65	-60	-55	-50	-45	-40	-35	-30	-25	-20	-15	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105
4	-84	-80	-76	-72	-68	-64	-60	-56	-52	-48	-44	-40	-36	-32	-28	-24	-20	-16	-12	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84
3	-63	-60	-57	-54	-51	-48	-45	-42	-39	-36	-33	-30	-27	-24	-21	-18	-15	-12	-9	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63
2	-42	-40	-38	-36	-34	-32	-30	-28	-26	-24	-22	-20	-18	-16	-14	-12	-10	-8	-6	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42
1	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	-21	**-20**	**-19**	**-18**	**-17**	**-16**	**-15**	**-14**	**-13**	**-12**	**-11**	**-10**	**-9**	**-8**	**-7**	**-6**	**-5**	**-4**	**-3**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**

Consequence

Table 10-3: Significance Rating Description

Score	Description	Rating
109 to 147	A very beneficial impact that may be sufficient by itself to justify implementation of the project. The impact may result in permanent positive change	Substantial (positive)
73 to 108	A beneficial impact which may help to justify the implementation of the project. These impacts would be considered by society as constituting a major and usually a long-term positive change to the (natural and / or social) environment	Major (positive)
36 to 72	An positive impact. These impacts will usually result in positive medium to long-term effect on the natural and / or social environment	Minor (positive)
3 to 35	A small positive impact. The impact will result in medium to short term effects on the natural and / or social environment	Negligible (positive)
-3 to -35	An acceptable negative impact for which mitigation is desirable. The impact by itself is insufficient even in combination with other low impacts to prevent the development being approved. These impacts will result in negative medium to short term effects on the natural and / or social environment	Negligible (negative)
-36 to -72	A minor negative impact requires mitigation. The impact is insufficient by itself to prevent the implementation of the project but which in conjunction with other impacts may prevent its implementation. These impacts will usually result in negative medium to long-term effect on the natural and / or social environment	Minor (negative)
-73 to -108	A moderate negative impact may prevent the implementation of the project. These impacts would be considered as constituting a major and usually a long-term change to the (natural and / or social) environment and result in severe changes.	Major (negative)
-109 to -147	A major negative impact may be sufficient by itself to prevent implementation of the project. The impact may result in permanent change. Very often these impacts are immitigable and usually result in very severe effects. The impacts are likely to be irreversible and/or irreplaceable.	Substantial (negative)

10.1 Project Activities Assessed

The following are the activities which were assessed in this air quality study:

- Wind erosion of the following sources: Laydown Area, GGA, GG10B, extension area and Multiproduct Stockyard; and
- The materials handling (offloading) of coal from trucks onto the various stockpiles.

10.1.1 Potential Impacts anticipated

The following impacts are anticipated:

- Emissions of dust, PM_{10} and $PM_{2.5}$ to the atmosphere attributed to offloading activities and wind erosion processes;
- A reduction in the quality of ambient air.

10.2 Wind Erosion Impacts

Wind erosion of the various stockpiles will occur due to the availability of granular material - ranging from a wide range of particle size distribution. With high wind speed (≥ 5 m/s), the fine materials are airborne, and travel varying distances depending on the aerodynamic diameter. The heavier particulates are deposited closer to the source and vice versa.

10.2.1 Management Objectives/ Mitigation Measures

- To ensure that on-site and off-site emissions are within the South African air quality standard;
- To explore adequate mitigation measures for the protection of the environment, human health and wellbeing i.e. wetting of stockpile and use of suppressants ;
- Implement an emissions management programme once operation commence;
- Monitoring air quality on site, at upwind and downwind locations; and
- Regular review of monitoring data to ensure compliance with the standard.

10.2.2 Impact Ratings

Table 10-4: Wind erosion of stockpiles

Impact Description: Reduction in air quality due to airborne dust from wind erosion			
Dimension	**Rating**	**Motivation**	**Significance**
Pre-Mitigation			
Duration	Medium term: 1-5 years (3)	As these stockpiles will be functional for 5 years, wind erosion will occur for the life of the stockpile.	Minor (negative) 42

Extent	Limited (2)	The impacts will be limited to the site and its immediate surroundings	
Intensity x type of impact	Minor (2)	There will be minor impact on air quality	
Probability	Almost certain (6)	It is most certain that the wind erosion will occur.	
Mitigation/ Management actions			
▪ Minimise drop heights when offloading material; ▪ Set maximum speed limits and have these limits enforced on stockpiles.			
Post-Mitigation			
Duration	Medium term: 1-5 years (3)	As these stockpiles will be functional for 5 years, wind erosion will occur for the life of the stockpile.	Negligible (negative) 24
Extent	Limited (2)	The impacts will be limited to the development area	
Intensity	Minimal (1)	Minimal impact on baseline air quality	
Probability	Probable (4)	When the above mitigation measures are implemented,	

10.3 Materials handling (offloading) coal onto stockpiles

The material handling process focused on the offloading of coal i.e. tipping of coal onto stockpiles from haul trucks. This is not a continuous process, as it happens at intervals. Depending on the moisture content and the wind speed intensity at the time, fine coal can be airborne leading to fugitive emissions.

10.3.1 Management Objectives/ Mitigation Measures

- To ensure that on-site and off-site emissions are within the South African air quality standard;
- To explore adequate mitigation measures for the protection of the environment, human health and wellbeing;
- Implement an emissions management programme once operation commence i.e. increase the moisture content of transported material;
- Monitoring air quality on site, at upwind and downwind locations; and
- Regular review of monitoring data to ensure compliance with the standard..

10.3.2 Impact Ratings

Table 10-5: Materials handling (offloading)

Impact Description: Reduction in air quality due to fugitive emissions from off loading			
Dimension	**Rating**	**Motivation**	**Significance**
Pre-Mitigation			
Duration	Medium term: 1-5 years (3)	As these stockpiles will be functional for 5 years, materials handling will take place for the life of the stockpile.	Minor (negative) 35
Extent	Limited (2)	The impacts will extend as far as the development site area	
Intensity	Minor (2)	There will be minor impact on air quality	
Probability	Likely (5)	The impact is likely to occur.	
Mitigation/ Management actions			
▪ Watering at offloading points			
Post-Mitigation			
Duration	Medium term: 1-5 years (3)	As these stockpiles will be functional for 5 years, materials handling will take place for the life of the stockpile.	Negligible (negative) (20)
Extent	Very Limited (1)	The impacts will be very limited to isolated areas	
Intensity x type of impact	Minimal (1)	There will be minor impact on air quality	
Probability	Probable (4)	When the above mitigation measures are implemented, it is probable that erosion might still occur.	

11 MONITORING PROGRAMME

11.1 Dust Monitoring Programme

Grootegeluk Mine management should continue the current dust and PM10 monitoring programmes that are in place and for project life in order to amass historical dust deposition data that will feed into management plans and practices aimed at reducing impacts from their operations on ambient air quality.

12 RECOMMENDATIONS

Based on the results presented in the report, the following recommendations are supplied:

- Ensure that ambient air quality concentrations during the operational phase of the expansion activities comply with all relevant standards, and that air quality impacts on surrounding sensitive receptors are minimised;
- Adherence to the suggested mitigation measures outlined in this report is recommended in order to reduce anticipated impacts;
- Ensure mitigation measures are in place for the protection of the environment, human health and wellbeing; and
- Assign a designated air quality officer to collect data/analyse and reporting to regulatory authorities on compliance.

13 CONCLUSION

An AQIA was undertaken to assess the proposed project impacts. Pollutants quantified and evaluated in the assessment included dust fallout, fine particulate matter (PM_{10} and $PM_{2.5}$). The model predictions presented in this report have shown that the proposed amendment will have a minimal impact on the background air quality. The predicted dust deposition rates, daily/annual PM_{10} and $PM_{2.5}$ concentrations simulate are all within the current South African air quality Standards.

It is worth mentioning that these impacts are mostly confined to the proposed project area, with less impact on the surrounding sensitive receptors. Mitigation measures as suggested in this report will help reduce the emissions from these sources i.e. application of wetting agents.

The emissions from the dispersion modelling were reported at the boundary and at the various sensitive receptors surrounding the project boundary and these were compared against the regulatory limits. Results of the dispersion modelling exercise, coupled with the impact assessment ratings conducted show that impacts will be minor to negligible. The predicted highest, daily (10.2 µg/m³) and annual (0.9 µg/m³) PM_{10} concentration at the mine boundary were below the current standard of 75 µg/m³ and 40 µg/m³ respectively. The lowest daily ground level PM_{10} concentrations predicted at the sensitive receptor (Marapong and Droogeheuvel) was 1.7 µg/m³ and annual predicted PM_{10} concentration was 0.04 µg/m³ at Droogeheuvel.

The predicted $PM_{2.5}$ concentrations of 3 µg/m^3 (daily) and 0.3 µg/m^3 (annual) were below the current standard of 40 µg/m^3 and 20 µg/m^3. The lowest daily and annual ground level $PM_{2.5}$ concentrations predicted at the sensitive receptor of 0.6 µg/m^3 and 0.02 µg/m^3 was predicted at Marapong.

The dust deposition rates predicted at the mine boundary are within the recommended standards for residential (600 mg/m^2/day) and non-residential (1 200 mg/m^2/day) areas pre and post mitigation. If the dust deposition rate predicted at each receptor is added to the background, levels will not exceed recommended standards.

In conclusion, the proposed Grootegeluk Short Term Stockpile Amendment Project by Exxaro will have minimal impact on background air quality of the area as shown in the model predictions. It is important to note that in as much as the project has minimum significant impacts cumulatively, it will have an impact on the background air quality. However, if mine management ensures that mitigation measures are in place at the mine once operation commences, impacts can be reduced below the levels predicted in this report.

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