AIR QUALITY

Impact Report

Vametco Bushveld – Air quality report

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1. INTRODUCTION

Kijani Green Energy was appointed by Nsovo Environmental Consultants (Pty) Ltd (Nsovo) to provide specialist air quality input into environmental Impact Assessment application for the proposed expansion Bushveld Vametco Alloys (BVA)'s operations and the associated Atmospheric Emissions Licence (AEL) amendment application required therefore.

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

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

This report is compiled for an environmental impact assessment for the proposed expansion of the activities at BVA as well as in support of an amendment application for the following aspects of the Atmospheric Emissions Licence held by BVA:

- The installation of a new scrubber system at the rotary kiln to improve air quality management at the plant.
- The installation of a new bag filter unit at the shaft furnaces to improve air quality management at the plant.

In addition, the following non-AEL controlled changes are proposed:

- The expansion of the existing slimes dam towards the east of the mine to cater for additional slimes waste;
- The expansion of the magnetite dump to the north and south of the mine;
- The construction of the two Pollution Control Dams (PCDs) for the proposed magnetite dump expansion and existing plant to accommodate the return or polluted water;
- Development of the new Return Water Dam (RWD) to accommodate return/polluted water from the proposed and existing slimes dams as well as to accommodate stormwater within the mine;
- Construction of a Barren Dam (BD) to store barren and mother liquor solution; and
- Development of a new Waste Rock Dump (WRD) to reduce load and haul distance and facilitate easy backfill.
- Then expansion of the plant facilities to cater for additional capacity.

2. ENTERPRISE DETAILS

Table 1: Enterprise details

Enterprise Name	EFRAZ Vametco Alloys (Pty) Ltd
Trading As	Vametco
Type of Enterprise, e.g. Company/Close Corporation/Trust, etc	Company
Registered Address	Main Mothotlung Rd Extension ODI Krokodilkraal District Brits NW
Postal Address	PO Box 595 Brits 0250
Telephone Number (General)	012 318 3200
Fax Number (General)	012 318 3201
Industry Type/Nature of Trade	Vanadium production
Land Use Zoning as per Town Planning Scheme	Mining / Industrial

2.1 Location and extent of plant

Table 2: Location and extent of plant

Physical Address of the Plant	Main Mothotlung Rd Extension ODI Krokodilkraal District Brits NW
Erf	-
Coordinates	25.580 S 27.876 E
Extent (km²)	11.08 km^2
Elevation Above Mean Sea Level (m)	1170m
Province	North West Province
Metropolitan/District Municipality	Bojanala Platinum Municipality
Local Municipality	Madibeng Local Municipality
Designated Priority Area	Waterberg Bojanala Priority Area

The BVA site is situated approximately 10km northeast of Brits, in the North West Province, at 23°33'44.41"S 27°52'57.50" E and at an altitude of 1170m above sea level.

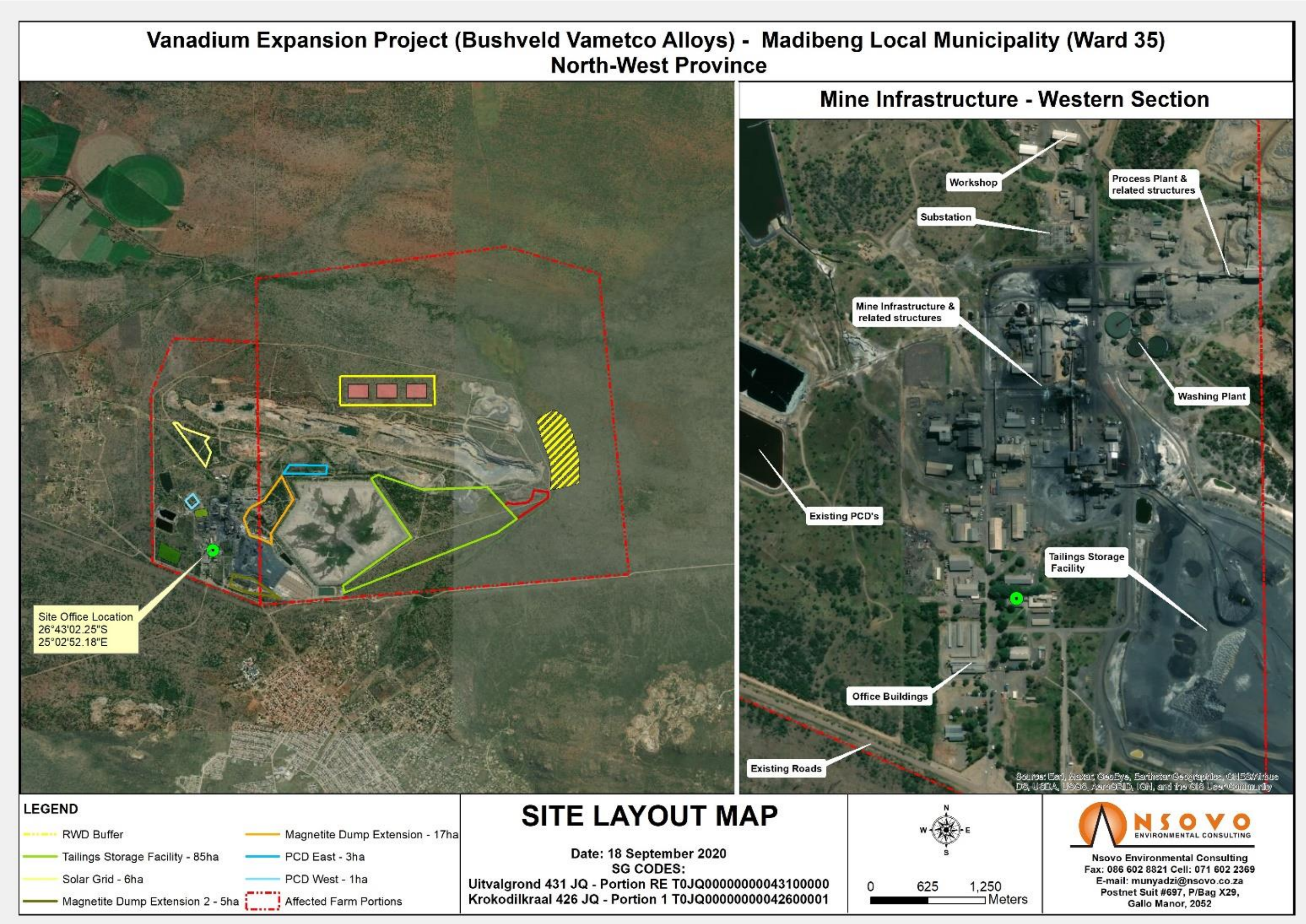


Figure 1. Location of Bushveld Vametco Alloys, near Brits, North West Province.

2.2 Atmospheric Emissions Licence and Environmental Impact Assessment

The project is situated in the North West Province, in the Bojanala Platinum District Municipality of North West, who act as the licensing authority of the AEL. This area has been formally declared as an the Waterberg Bojanala Air Quality priority area in terms of Section 18(1) of the National Environmental Management: Air Quality Act 2004 (Act No. 39 of 2004) (AQA).

2.2.1 Atmospheric Emissions Licence (AEL) renewal

BVA's AEL is valid until 31 March 2020. This report primarily provides an air quality assessment as input for the EIA being conducted for the proposed expansion of the operations at BVA. In addition, it provides potential input into a renewal application for that licence with some variations included. The variations include:

- Installation of a new scrubber system at the rotary kiln.
- Installation of a new bag filter unit at the shaft furnaces.

2.2.2 National Ambient Air Quality Standards

The following national ambient air quality standards have relevance:

Table 3: National ambient air quality standards for sulphur dioxide (SO_2)

Averaging period	Concentration	Frequency of exceedence	Compliance date
10 minutes	500 µg/m^3	526	Immediate
1 hour	350 µg/m^3	88	Immediate
24 hours	125 µg/m^3	4	Immediate
1 year	50 µg/m^3	0	Immediate
The reference method for analysis of sulphur dioxide shall be ISO 6767			

Table 4: National ambient air quality standards for nitrogen dioxide (NO_2)

Averaging period	Concentration	Frequency of exceedence	Compliance date
1 hour	200 µg/m^3	88	Immediate
1 year	40 µg/m^3	0	Immediate
The reference method for analysis of nitrogen dioxide shall be ISO 7996			

Table 5: National ambient air quality standards for particulate matter (PM_{10})

Averaging period	Concentration	Frequency of exceedence	Compliance date
24 hours	120 µg/m^3	4	Immediate
24 hours	75 µg/m^3	4	1 January 2015
1 year	50 µg/m^3	0	Immediate
1 year	40 µg/m^3	0	1 January 2015
The reference method for analysis of nitrogen dioxide shall be ISO 7996			

Table 6: National ambient air quality standards for carbon monoxide (CO)

Averaging period	Concentration	Frequency of exceedence	Compliance date
1 hour	30 mg/m^3 (26ppm)	88	Immediate
8 hour (calculated on 1 hourly averages)	10 mg/m^3 (8.7ppm)	11	Immediate
The reference method for analysis of carbon monoxide shall be ISO 4224			

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

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

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

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

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

3. NATURE OF THE PROCESS

3.1 Listed activities

The activities on site trigger the following listed activities[2]:

Table 6: Listed activities

Category	Listed activity number	Name	Description
4	4.18	Vanadium ore processing	The processing of vanadium-bearing ore or slag for the production of vanadium oxides or vanadium carbide by the application of heat

3.2 Process description

The BVA site produces vanadium products from vanadium-bearing magnetite ore and slag. During periods of low market demand, the open-cast mine and concentration plant operations are not operated.

3.2.1 Mine

The mining operation is open-cast, capable of mining 2.5 to 3million tonnes of rock per year, of which approximately half is waste rock. The operation includes stockpiling and intermediate crushing

3.2.2 Concentration plant

The concentration plant receives magnetite and concentrates it through crushing, screening, milling and magnetic separation. Waste is pumped to the slimes dams for storage.

3.2.3 Rotary kiln

Extraction is a two step process:

[2] As per Department of Environmental Affairs, no 248, 31 March 2010. Listed activities and associated minimum emission standards identified in terms of Section 21 of the National Environmental Management Act: Air Quality Act 2004 (Act no 39 of 2004)

The rotary kiln section extracts vanadium from the magnetite from the concentration plant or from vanadium-bearing slag purchased from suppliers. A mixture of magnetite, vanadium-bearing slag, sodium sulphate and sodium carbonate are fed into a coal-fired kiln. The soluble product is fed to a leaching section. The replacement of this unit's scrubber marks part of the new infrastructure included in this report.

3.2.4 Leaching

The kiln product is water leached over two large belt filters. Magnetite tailings are disposed of on the tailings dump while the vanadium-bearing liquor is pH adjusted before being fed to the precipitation plant.

3.2.5 Precipitation plant

The vanadium-bearing liquor is mixed with ammonium sulphate and ammonium metavanadate (AMV) is precipitated. The precipitated AMV is separated from the vanadium-depleted solution. The AMV is transferred to the vanadium trioxide reactors.

3.2.6 Sulphate recovery plant

The barren solution is concentrated in a steam-heated, coal-fired evaporation plant and sodium sulphate is crystallised and returned to the kiln.

3.2.7 Modified vanadium oxide (MVO) reactors

Dry AMV is fed into the MVO reactors and converted to vanadium oxide in two electrically heated rotary reducing furnaces.

3.2.8 Mix plant

The MVO product is fed to the mix plant where it is mixed with carbon starch and fibre to produce briquettes. These are then dried.

3.2.9 Nitrovan furnaces

The dried briquettes are fed into four Nitrovan furnaces which produce the final Nitrovan product which is packaged and shipped.

All facilities operate 24 hours a day and 365 days per year, market dependent.

3.3 Unit processes

Table 7: Unit processes

Unit process	Unit process function	Batch or continuous
Raw material handling	Storage and manipulation of raw materials	Continuous
Extraction: Rotary kiln	Roasting of ore with reagents to obtain water-soluble vanadium	Continuous
Extraction: Leach section	Water-soluble vanadium is leached from solid kiln product	Continuous
Extraction: Precipitation	Vanadium is extracted in solid form from vanadium-bearing liquor	Continuous
Refining: Sulphate recovery plant	Recovery of solid sodium sulphate	Continuous
Refining: MVO	Production of MVO	Continuous
Refining: Mix plant	Preparation of feed material for Nitrovan furnaces	Continuous
Refining: Nitrovan furnaces	Production of Nitrovan	Continuous

4. TECHNICAL INFORMATION

4.1 Raw materials used

Table 8. Raw materials used

Raw material type	Maximum permitted consumption rate	Design production capacity (volume)	Actual production capacity	Units (quantity / period)
Vanadium-bearing ore and slag	35200	35200	31200	t/pm
Soda ash	1900	1900	1680	t/pm
Coal (for kiln)	1900	1900	1680	t/pm
Sodium sulphate	2000	2000	1770	t/pm
Ammonium sulphate	1050	1050	930	t/pm
Coal (for boilers)	1650	1650	1460	t/pm
Nitrogen	1250	1250	1110	t/pm
LP Gas	26	26	23	t/pm
PVA Binder	30	30	26	t/pm
Other binder	58	58	51	t/pm
Carbon	230	230	205	t/pm

Table 9: Product produced

Product type	Maximum permitted production rate	Design production capacity (volume)	Actual production capacity	Units (quantity / period)
Calcines	35000	35000	31000	t/pm
AMV	1166	1166	500	t/pm
MVO	746	746	700	t/pm
Nitrovan	702	702	550	t/pm
FeV	650	650	0	t/pm

Table 10: Energy sources used

Energy source	Maximum permitted production rate	Design production capacity (volume)	Actual production capacity	Units (quantity / period)
Coal (duff)	1900	1900	1680	t/pm
Coal (peas)	1650	1650	1460	t/pm
Fuel	120	120	70	t/pm
LP Gas	26	26	23	t/pm

5. ATMOSPHERIC EMISSIONS

5.1 Point source parameters

Table 10: Point source parameters

Unique Stack ID	Source Name	Latitude (decimal degrees)	Longitude (decimal degrees)	Height of Release Above Ground (m)	Diameter at Stack Tip / Vent Exit (m)	Actual Gas Exit Temperature (°C)	Actual Gas Volumetric Flow (m^3/hr)	Actual Gas Exit Velocity (m/s)
V_01K	Rotary kiln stack	25.5788	27.8772	55	1.54	70	93193	16.8
V_02PP	Precipitation stack	25.5800	27.8761	35	0.645	43.8	17415	7.5
V_03B1	Boiler 1&2 stack	25.5775	27.8761	130	1.09	27	47315	14.8
V_04B3	Boiler 3 stack	25.5775	27.8761	160	0.79	29.5	23658	13.41
V_05MVO	MVO production stack	25.5797	27.8758	40	0.67	39.1	16160	6.7
V_08S1	Nitrovan Furnace 1 stack	25.5794	27.8752	190	0.345	51	8413	24.5
V_09S2	Nitrovan Furnace 2 stack	25.5794	27.8752	190	0.345	51	8413	24.5
V_10S3	Nitrovan Furnace 3 stack	25.5794	27.8752	190	0.345	51	8413	24.5
V_11S4	Nitrovan Furnace 4 stack	25.5794	27.8752	190	0.345	51	8413	24.5

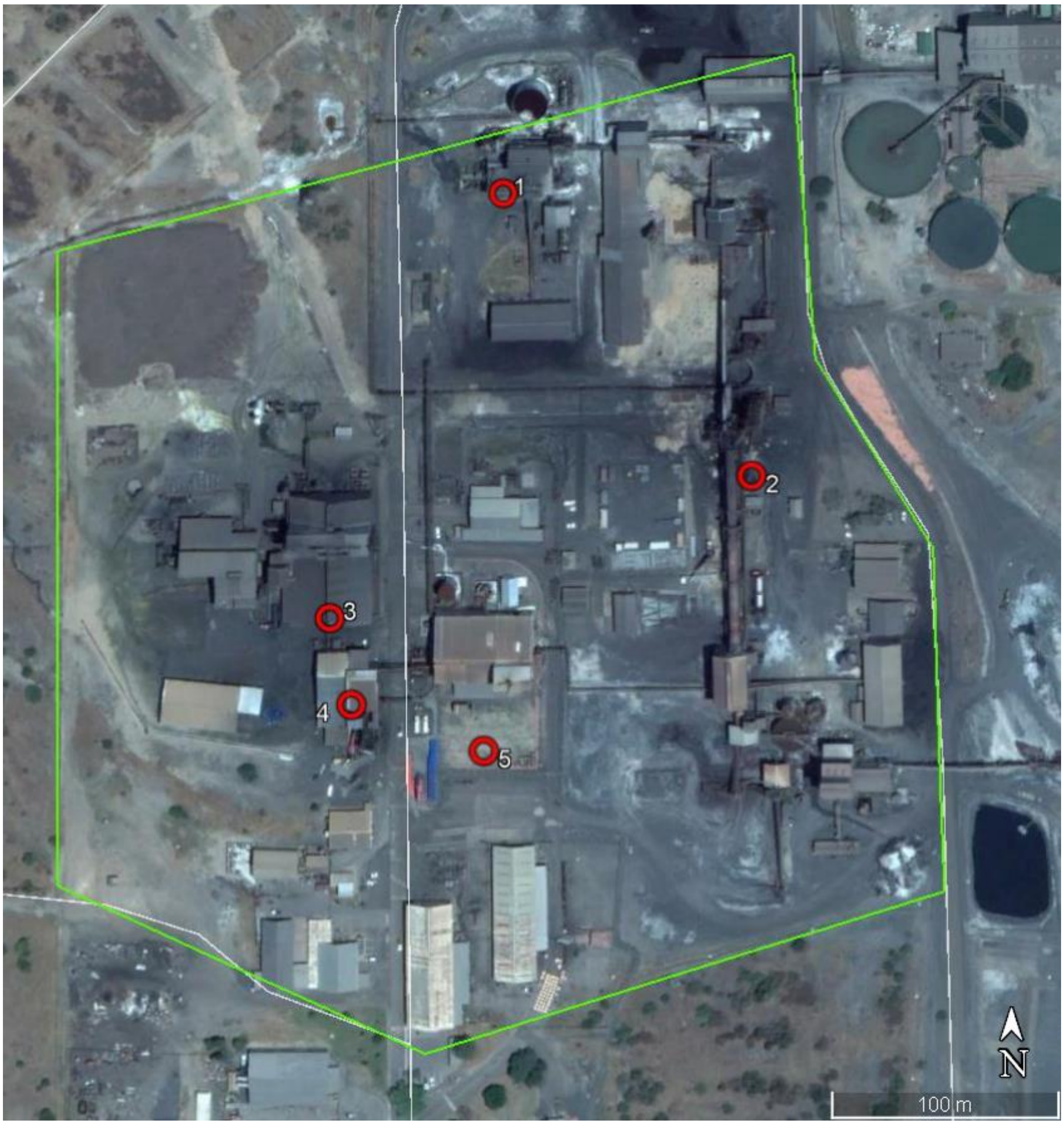


Figure 2: Point source locations for the Bushveld Vametco plant

For the above figure, the following locations are relevant:

1- Boiler stacks
2- Rotary kiln
3- Nitrovan furnaces
4- Mix plant
5- Precipitation plant

Emissions have been monitored regularly. The table below indicates the emission limits as prescribed in BVA's Atmospheric Emissions Licence (AEL) and the equivalent measured emissions.

Table 11: Stack emission compliance for BVA. All figures in mg/Nm^3.

Source name	Source code	Emission limits			Actual measured emissions[3]		
		PM	SO2	NH3	PM	SO_2	NH_3
V_01K	Rotary kiln stack	50	1200	30	122.9	248.8	56.2
V_02PP	Precipitation stack	50	1200	30	37.54	0.3	41
V_03B1	Boiler 1&2 stack	50	1200	n/a			
V_04B3	Boiler 3 stack	50	1200	n/a			
V_05MVO	MVO production stack	50	1200	30	33.84	0.1	45.2
V_08S1	Nitrovan Furnace 1 stack	50	1200	n/a	163.7	4.6	
V_09S2	Nitrovan Furnace 2 stack	50	1200	n/a			
V_10S3	Nitrovan Furnace 3 stack	50	1200	n/a			
V_11S4	Nitrovan Furnace 4 stack	50	1200	n/a			

[3] As per EnviroNgaka reports Feb 2019

5.2 Fugitive emissions

Portions of the site are made up of exposed material, either in the shape of waste dumps or raw materials handling areas. Three possible new sources of fugitive wind entrained dust emissions are proposed for the site and it is these that are tabulated below.

Table 12: Fugitive emission sources

Source Name	Source Description	Latitude (decimal degrees) of SW corner	Longitude (decimal degrees) of SW corner	Height of Release Above Ground (m)	Length of Area (m)	Width of Area (m)
Rock Waste dump Alternative 1	Waste dump area	25°34’38”	27°54’25”	20	220	440
Return Water Dam	Waste dump area	25°34’21”	27°54’36”	20	850	330
Rock Waste dump Alternative 2	Waste dump area	25°33’58”	27°53’35”	20	800	140

Figure 4: New fugitive source locations for the BVA site

Rock Waste Dump, Alt 1

Rock Waste Dump, Alt 2

Additional waste dump

6. IMPACT OF ENTERPRISE ON THE RECEIVING ENVIRONMENT

6.1 Analysis of impact on human health

6.1.1 Particulate matter

Of the pollutants modelled, only PM10 appears to occur at high enough ambient levels to be of concern. For non-combustion fugitive sources, PM10 should be considered a proxy for total suspended particulates.

PM10 is associated with pulmonary disorders in humans and livestock and can negatively impact crops. The improvements recommended for this plant, which are included in this study, should reduce the combustion emissions of particulates to below national ambient standards for PM10.

7. COMPLAINTS

No complaints for this reporting period are indicated.

8. CURRENT OR PLANNED AIR QUALITY INTERVENTIONS

BVA is currently undergoing a series of improvements which will all have a material, positive impact on the emissions from the plant. Specifically, particulate emissions are being tackled through the following additions:

- The installation of a new scrubber system at the rotary kiln to improve air quality management at the plant.
- The installation of a new bag filter unit at the shaft furnaces to improve air quality management at the plant.

9. COMPLIANCE AND ENFORCEMENT ACTIONS

The applicant is not currently under any compliance notifications nor has received any enforcement actions in this licensing period.

10. ADDITIONAL INFORMATION

10.1 Combustion emissions

The following stacks are flagged as having a high contribution to the overall emission profile of the plant:

- Rotary kiln – currently exceeding compliance for particulates but is part of the re-engineering of the plant to improve emissions profile and performance
- Nitrovan furnaces – currently exceeding compliance for particulates but is part of the re-engineering of the plant to improve emissions profile and performance

10.2 Climate description

No long term weather dataset was available for the site in question so Rustenburg, North West Province was selected as an acceptable proxy[4]. This station is 40km west of the project site with no significant differences in rainfall pattern, temperature variability or wind pattern.

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

[4] Pers comms., SAWS 2019

10.2.1 Wind

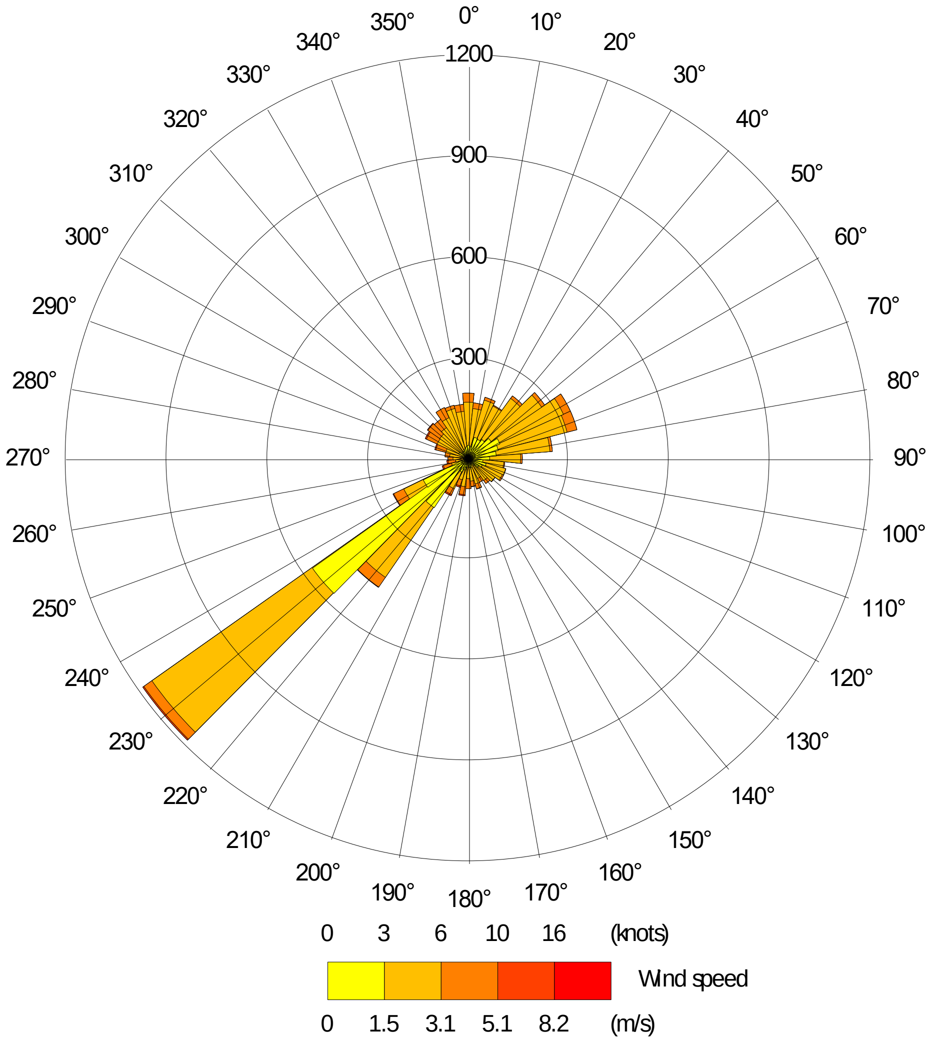


Figure 2. Annual wind rose for Rustenburg, North West Province, South Africa (SAWS, 2017).

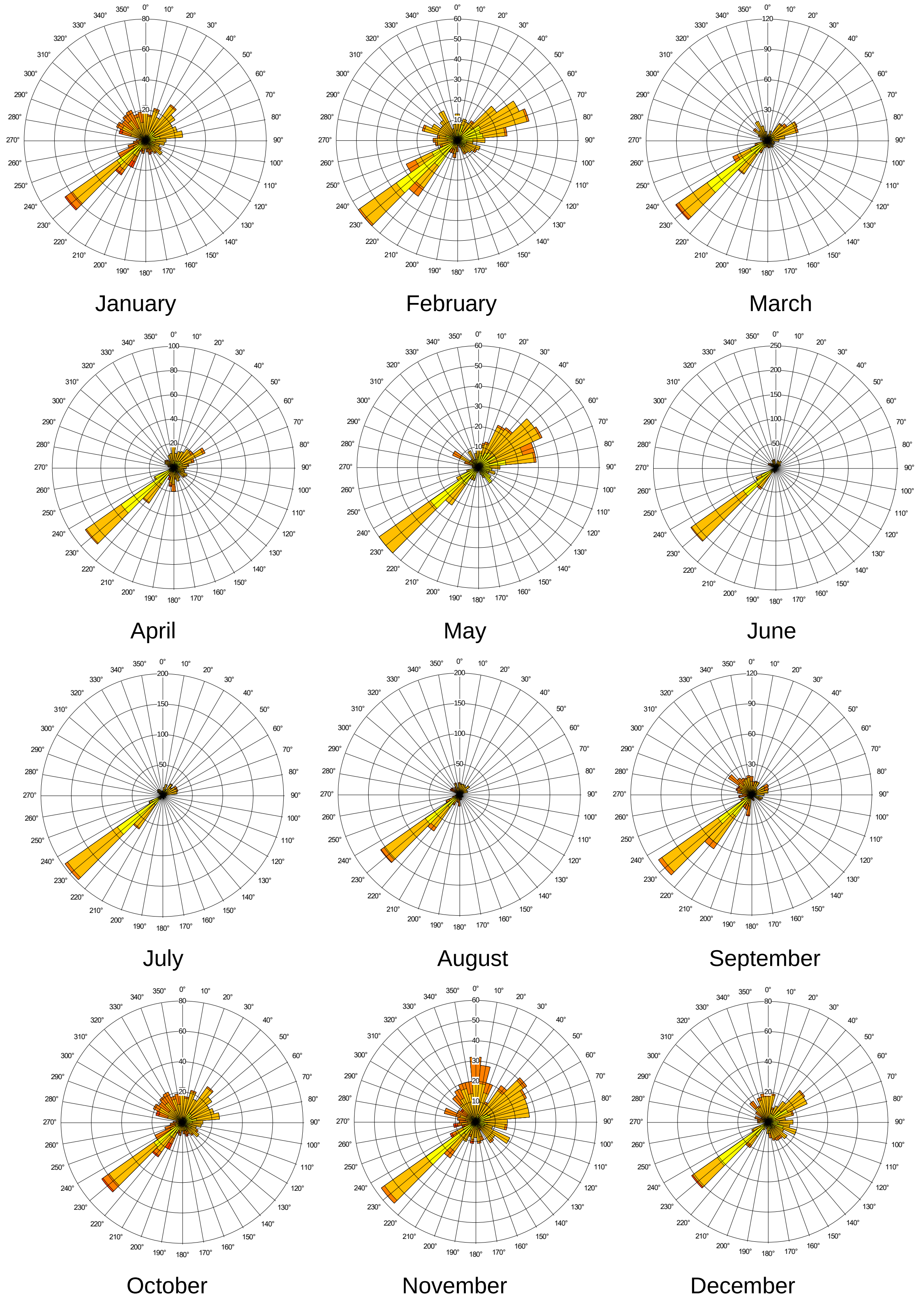


Figure 3. Average monthly wind direction and strength for Rustenburg, North West Province, South Africa (SAWS, 2017)

The prevailing winds are from the northeast, with dispersion from the site likely to be predominantly away from residential areas, in a southwesterly direction.

10.2.2 Precipitation

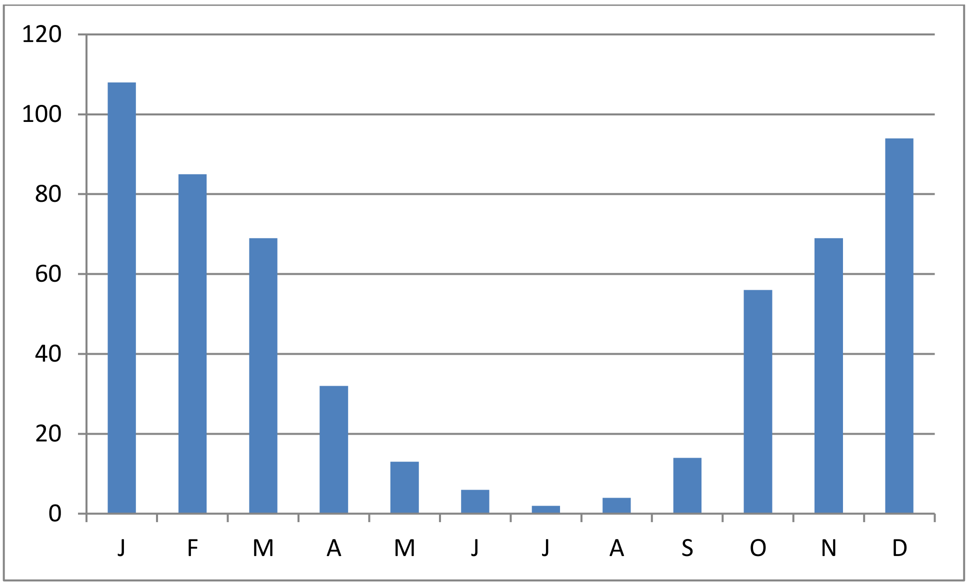


Figure 4: Average monthly rainfall figures for Rustenburg, North West Province, South Africa (SAWS, 1981- 2010) (mm per month)

The site is in the South African interior, at an altitude of approximately 1170m above sea level. It is in South Africa's summer rainfall region with an annual average rainfall of 550mm per year. Rain peaks mid- season, in January, while the winter months are characterised by a long and dry period.

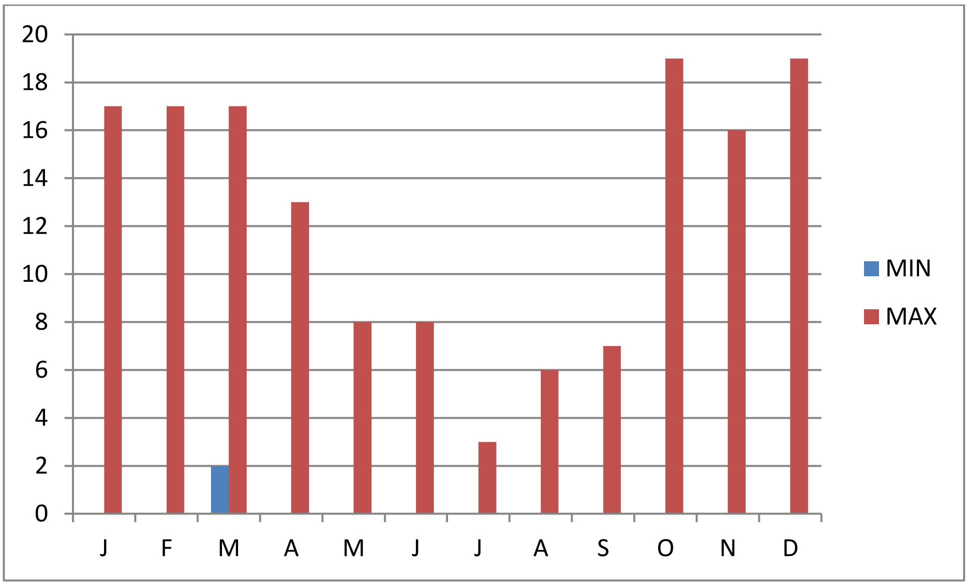


Figure 5: Maximum and minimum monthly rain days (days where precipitation exceeds 0.1mm) for Rustenburg, North West Province, South Africa (SAWS, 1981-2010) (number of days per month)

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

10.2.3 Temperature

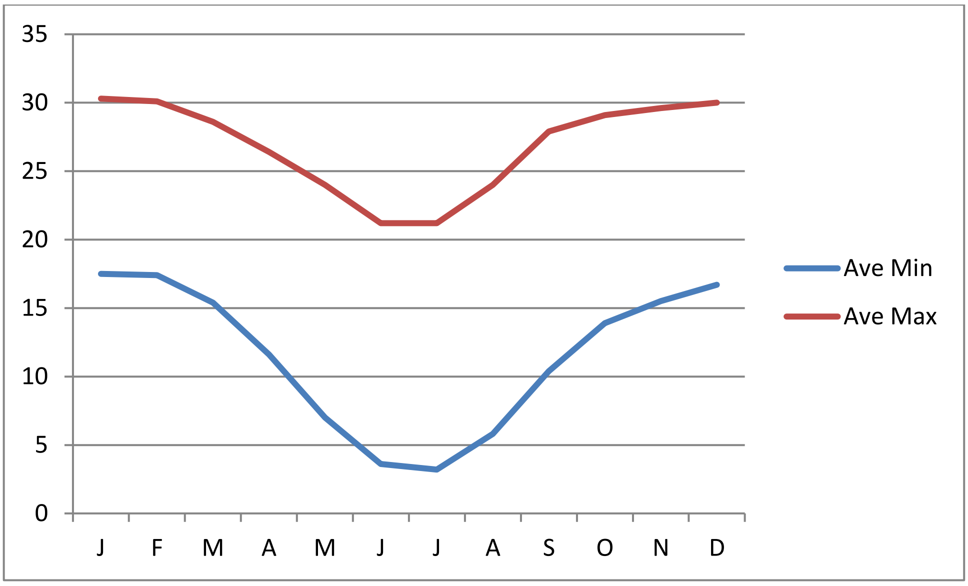


Figure 6: Average minimum and maximum daily temperature (Celsius) for Rustenburg, North West Province, South Africa (SAWS, 1981- 2010)

The warmest period is December / January, when maximum temperatures average above 30 degrees centigrade while June/July is the coldest period with daytime temperatures averaging 21 degrees and overnight temperatures occasionally dropping below freezing.

10.3 Site specific dispersion potential summary

The site is situated in a high altitude, inland region characterized by summer rains but where the winters are cool, dry and windy, resulting in conditions ideal for the desiccation of the environment and the wind entrainment of any loose material.

10.4 Modelling Methodology and assumptions

Emissions to air during the operation of a facility of this nature are generally limited to fugitive dust and combustion related emissions.

Of these, dust, oxides of nitrogen, sulphur dioxide and particulate matter make up the bulk of the emissions to air.

10.4.1 Meteorological data

Following discussions with SAWS, the nearest available hourly sequential dataset was identified as being that of Rustenburg, North West Province, for the year 2017, 40km west of the site. This is considered to be a reasonable proxy for the region's climate[5].

10.4.2 Pollutants

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

- Dust
- Combustion emissions

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

10.4.3 Baseline Air Quality Measurement Results

There is no existing ambient pollutant monitoring data available for this site. The nearest South African Air Quality Information System (SAAQIS) site is the Damonsville site approximately 10km to the southwest of the site. This site only monitors NO_2 and NO_x and returns results consistent with "Good" air quality (Green 1-3).

10.4.4 Combustion emissions

The degree to which combustion emissions become a polluter are determined by the following factors:

- Efficiency of combustion process
- Presence and efficiency of abatement equipment

[5] Personal communication, SAWS, 2019

- Height of stack and dispersal potential of plume
- Rate of process

10.4.5 Dust

The degree to which dust becomes a polluter is in direct relation to four factors:

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

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

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

TSP is also referred to as 'nuisance dust' and accounts for the visible dust that may settle and cause the clogging of machinery as well as have an adverse effect on local flora through the clogging of stomata.

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

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

10.5 Dispersion Modelling

Potential emission modelling is undertaken using Cambridge Environmental Research Consultants (CERC)'s latest generation model, the Atmospheric Dispersion Modelling System (ADMS 5) in association with the AERMOD model required by NEMA. Input data is a combination of field data and estimates generated using the Australian National Pollution Inventory (NPI) *Emission Estimation Technique Manual for Mining, Version 3.1*(2012), from which the fugitive dust figures are obtained. Meteorological data is sourced from the South African Weather Services (SAWS).

10.5.1 Emission factors

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

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

The emission factors used for fugitive dust for this study were taken from the Australian National Pollution Inventory (NPI)'s *Emission Estimation Technique Manual for Mining, Version 3.1*(2012). The emission factors contained therein are mostly based on those developed by the United States Environmental Protection Agency (USEPA, 1985 and 1998) and are in turn published in *Emission Factor Documentation for AP-42* itself considered an industry standard. South Africa has yet to develop its own set of emission factors.

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

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

where:

- $E_{kpy,i}$ = emission rate of pollutant i, kg/yr
- A = activity rate, t/h
- OpHrs = operating hours, h/yr
- EF_i = uncontrolled emission factor of pollutant i, kg/t
- CE_i = overall control efficiency for pollutant i, %

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

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

10.6 Results for current scenario (combustion emissions)

The model was run using current, measured emissions from the relevant stacks and fugitive sources[6]. The model was run once on a 5 000m by 5 000m grid, with centre point at 25°34'44.41"S 27°52'57.50" E.

10.6.1 Particulate matter

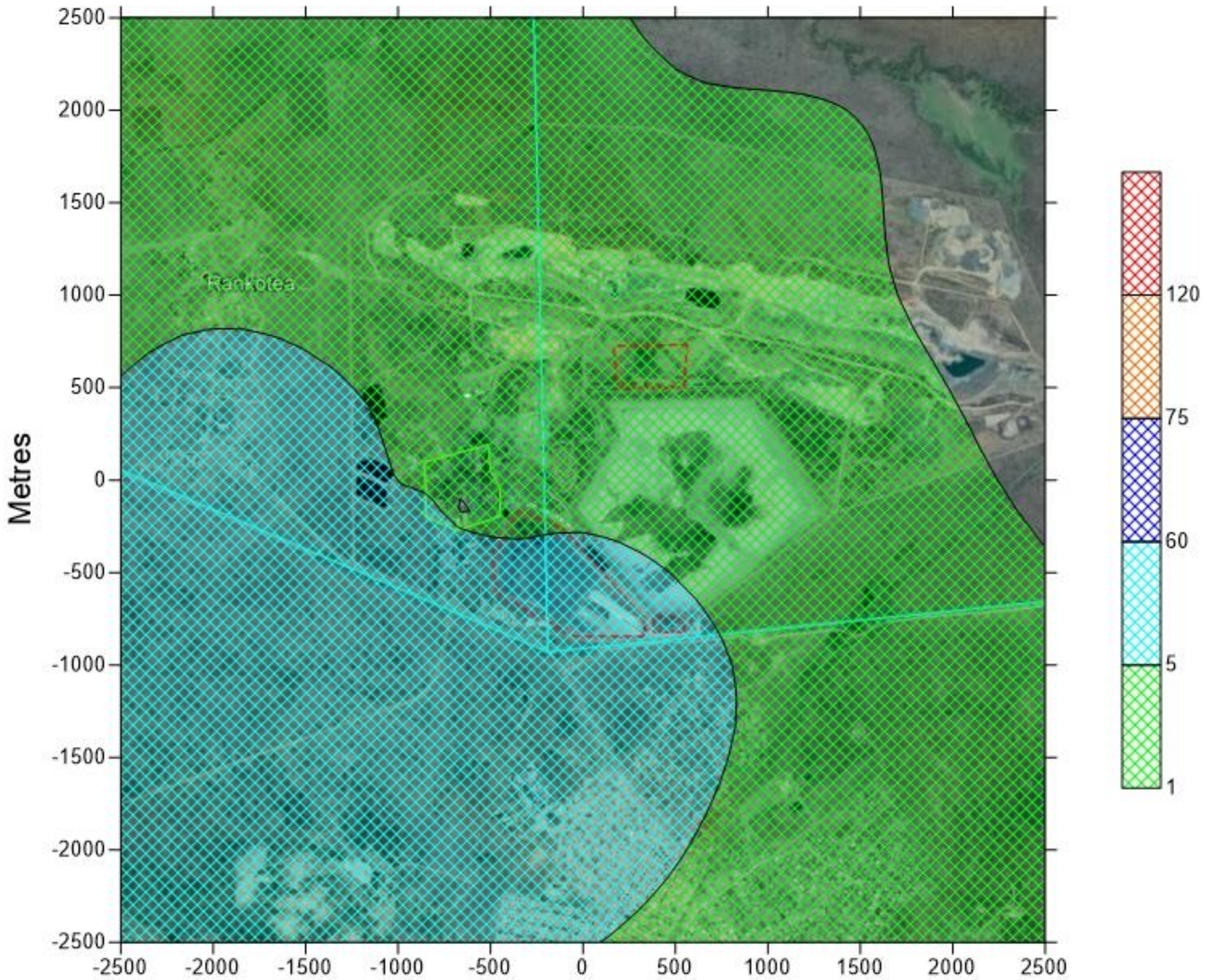


Figure 10: Modelled representation of current PM_{10} dispersion from combustion emissions from Bushveld Vametco Alloys. Long term averages, 24 hour averaging period, levels indicated in µg/m³

Dispersion is to the southwest with a broad plume extending out over the flat terrain in this direction. The high stacks and strong plume velocity do aid dispersion but it is clear that additional scrubbing of particulate matter will aid the plant's emission profile.

[6] As per EnviroNgaka reports Feb 2019

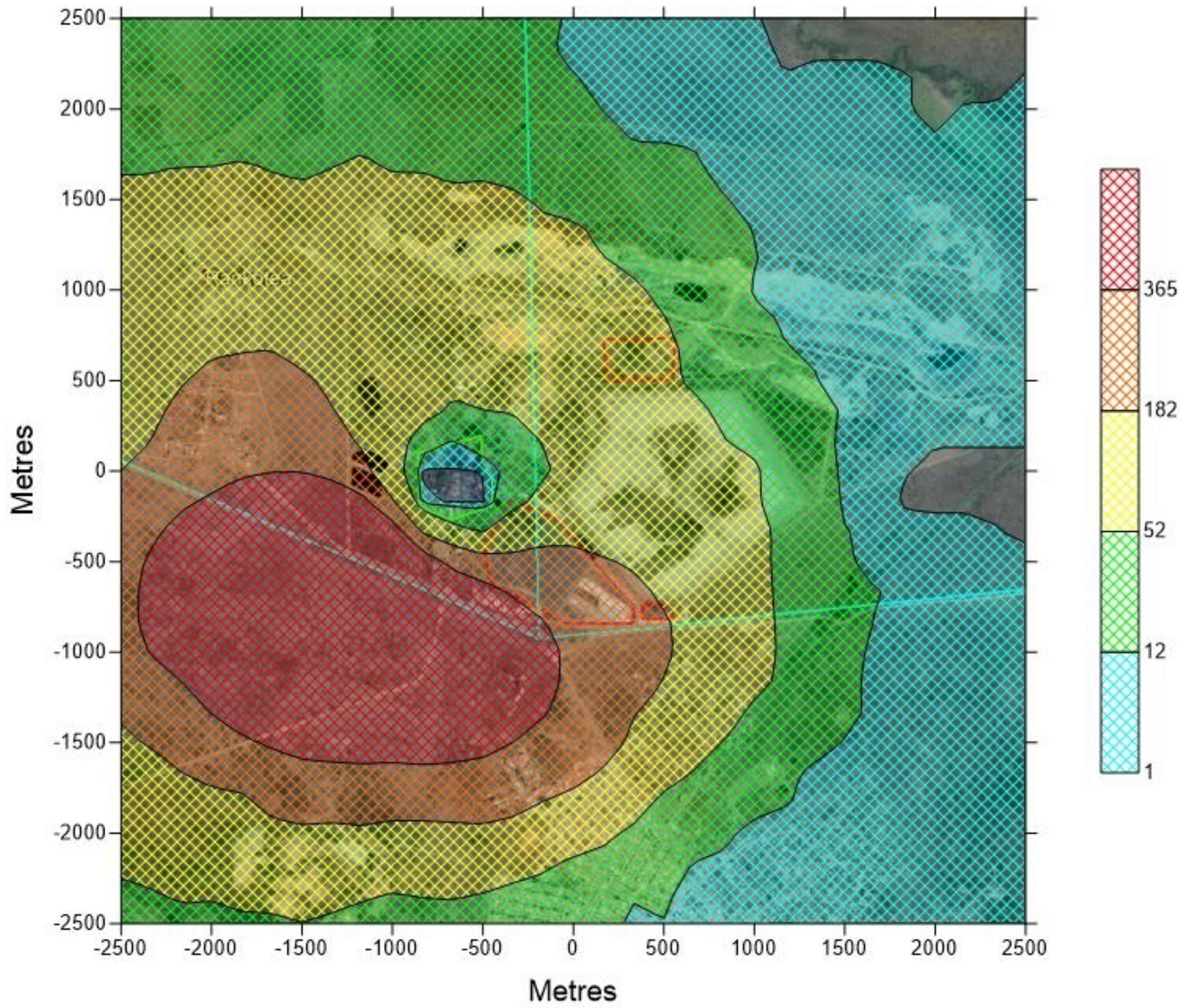


Figure 11: Modelled representation of incidences of exceedences of the 120 µg/m³ PM_{10} level from combustion emissions from Bushveld Vametco Alloys. Long term averages, 24 hour averaging period, levels indicated number of hourly exceedences per year.

Daily exceedences of the 120 µg/m³ PM_{10} level are expected to the southwest of the site with occasional exceedences expected up 2km to the southwest of the plant and 1.5km to the north.

10.6.2 Oxides of nitrogen

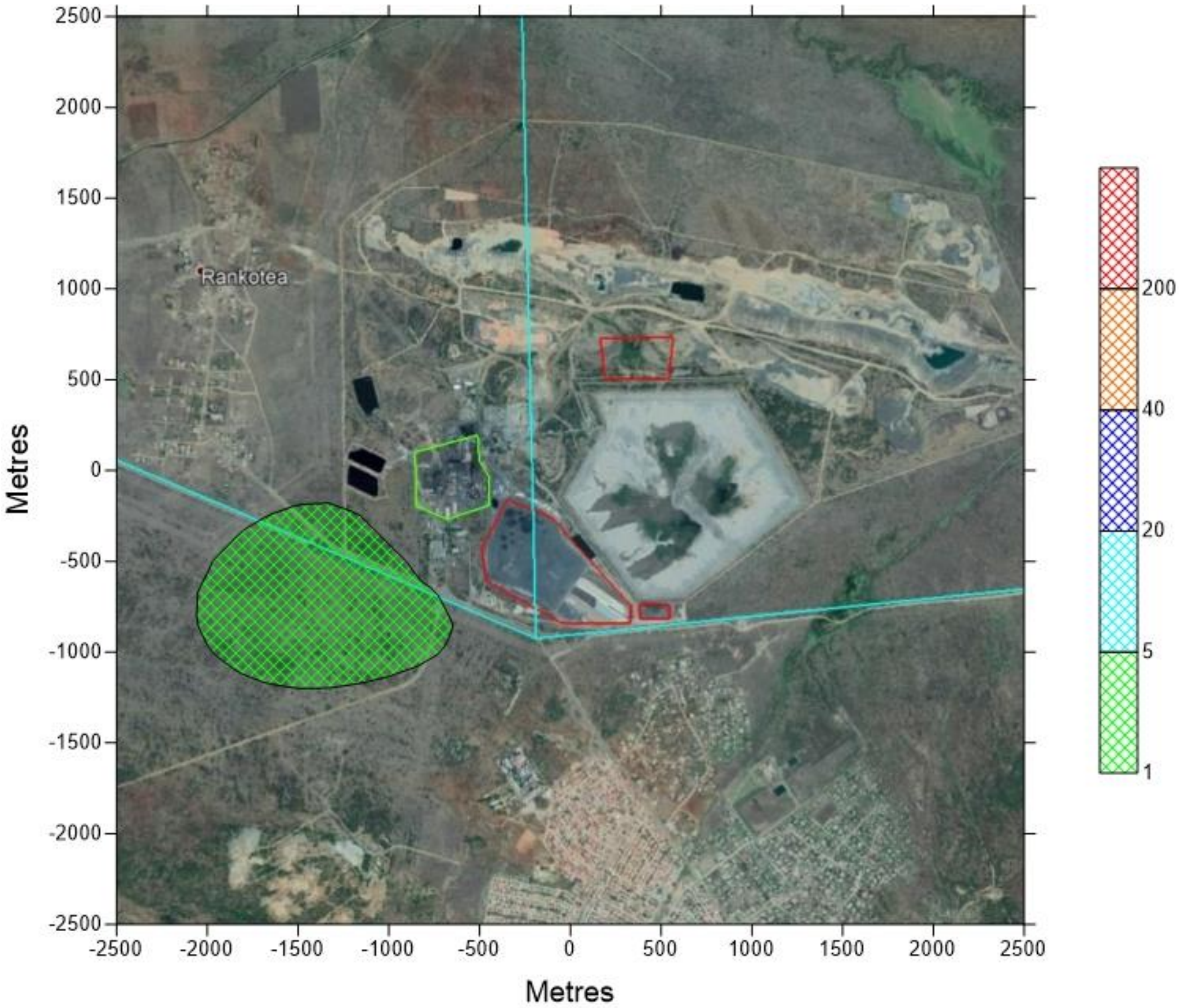


Figure 12: Modelled representation of current NO_x dispersion from combustion emissions from Bushveld Vametco Alloys. Long term averages, 24 hour averaging period, levels indicated in µg/m^3

Long term average levels of oxides of nitrogen resulting from combustion emissions at the BVA plant are likely to have minimal effects on the surrounding area, not significantly impacting the neighbouring residential areas.

The models showed no anticipated exceedences of the 200 µg/m^3 level as a result of combustion activities at the BVA plant.

10.6.3 Sulphur dioxide

Modelling of the long term average SO_2 levels likely to arise as a result of combustion activities at the BVA site showed low levels, below the 1 µg/m^3 level. The indication below is of the 100th percentile SO_2 concentrations, in other words, the highest single return of SO_2 concentration for each point of the grid, for the modelled year.

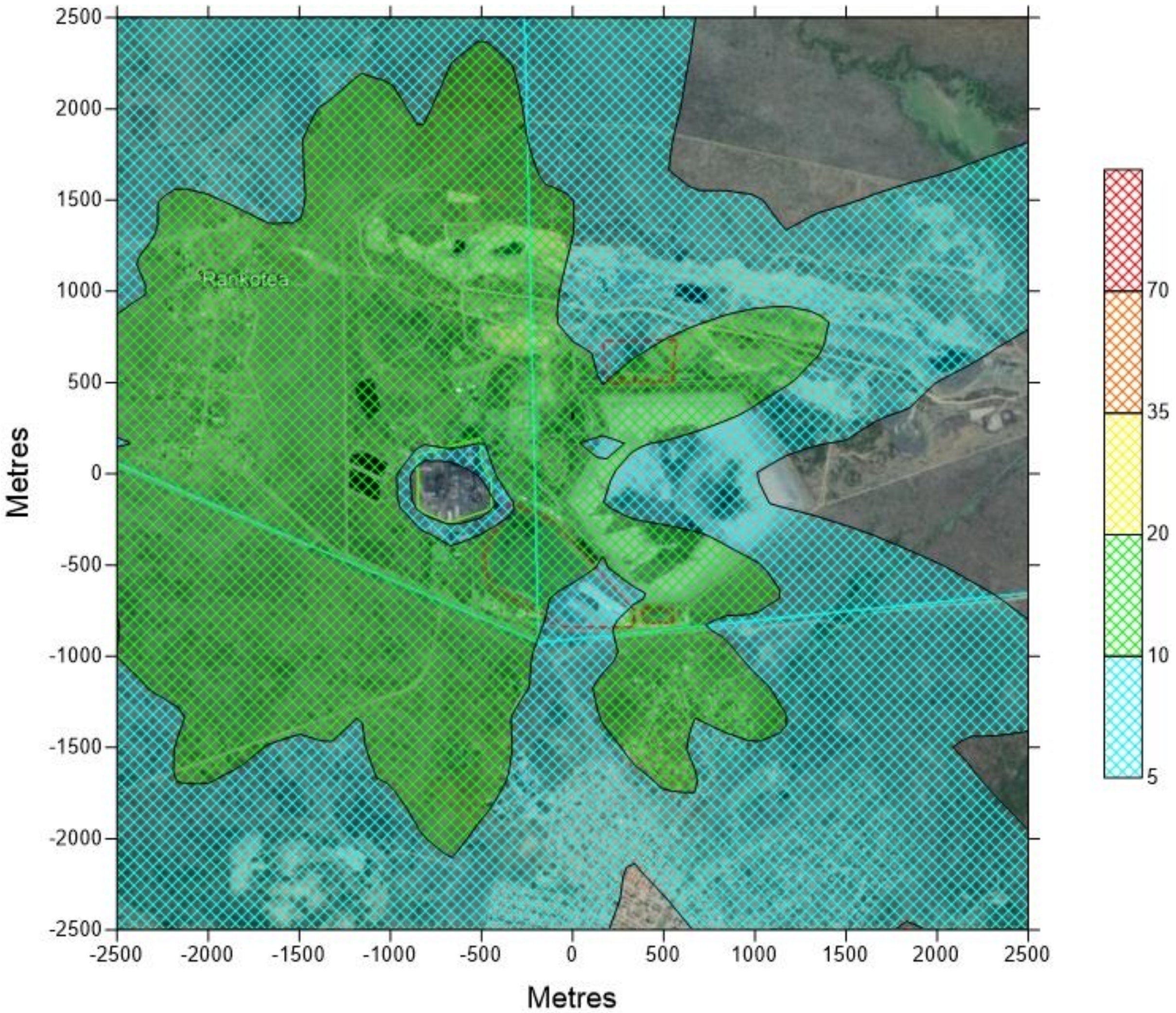


Figure 13: Modelled representation of SO_2 dispersion from combustion emissions from Bushveld Vametco Alloys. 100th percentile of long term averages, 24 hour averaging period, levels indicated in µg/m^3

The modelling of the SO_2 levels indicates occasional breaches of the 10 µg/m^3 level in the areas surrounding the processing plant. These occasional high levels are not anticipated to contribute to significant health impacts in the area.

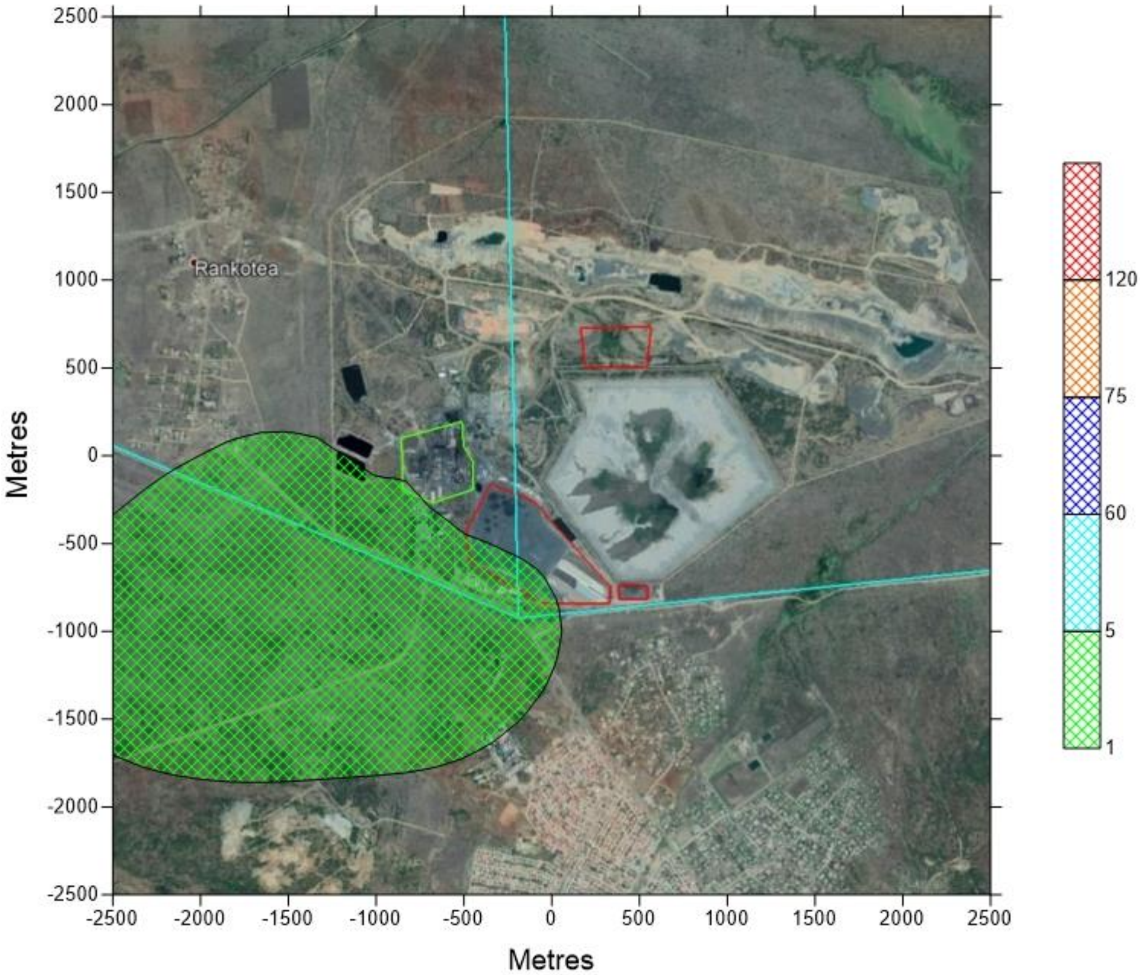
The models showed no anticipated exceedences of the 350 µg/m^3 level as a result of combustion activities at the BVA plant.

10.7 Results for compliance scenario (combustion emissions)

The model was run using current, measured emissions from the relevant stacks[7]. Those that were compliant were held at the same level. Those that were in excess of current compliance were modelled as compliant. To this end, the only relevant changes are in the PM10 levels and so only those are indicated here.

The model was run on a 5 000m by 5 000m grid, with centre point at 25°34'44.41"S 27°52'57.50" E.

10.7.1 Particulate matter



[7] As per EnviroNgaka reports Feb 2019

Figure 17: Modelled representation of current compliance PM_{10} dispersion from combustion emissions from Bushveld Vametco Alloys. Long term averages, 24 hour averaging period, levels indicated in µg/m^3

The compliant run shows low levels of combustion sourced PM_{10} to the southwest of the site. No exceedences of the 120 µg/m^3 level are indicated. This is a strong indicator of the benefits that will arise from the introduction of improved abatement technologies due to be installed at the rotary kiln and shaft furnaces, as proposed.

10.8 Results for fugitive emissions

The model was run using emission factor estimates for the proposed new fugitive sources. PM10 should be considered a proxy for total suspended particulates and these results should be seen merely as a guide for potential dust dispersion and recommended future dust monitoring networks.

The model was run on a 10 000m by 10 000m grid, with centre point at 25°34'44.41"S 27°52'57.50" E. Two alternatives were considered: Rock Waste Dump 1 (southeast of the mine) and Rock Waste Dump 2 (north of the mine). These were modelled separately.

10.8.1 Particulate matter alternative 1

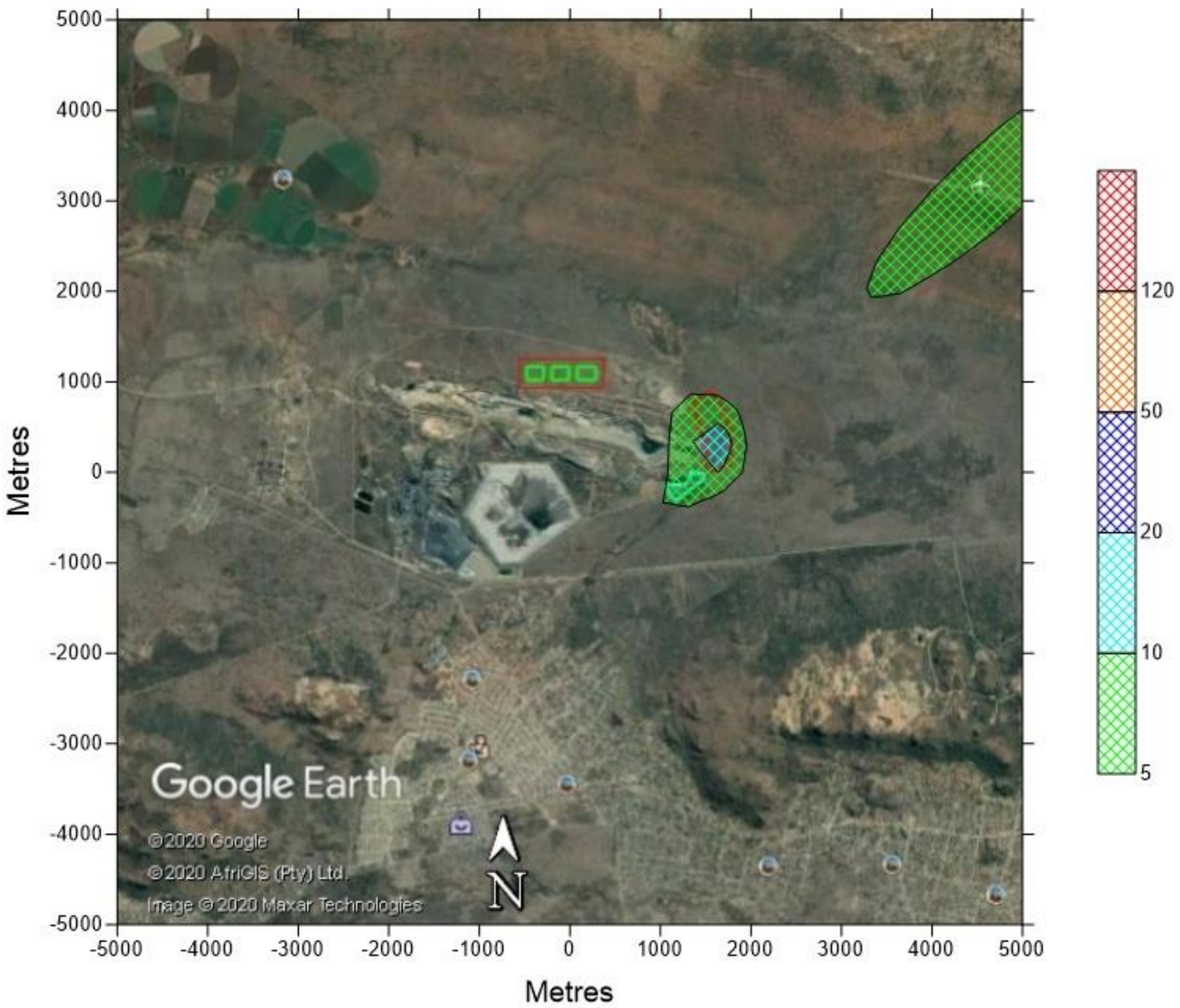


Figure 18: Modelled representation of current dust dispersion from fugitive emissions from Bushveld Vametco Alloys' proposed new installations, Alternative 1. Long term averages, 24 hour averaging period, levels indicated in µg/m^3

Dispersion is expected primarily to the northeast of the site with very low levels of dust expected elsewhere from the mine.

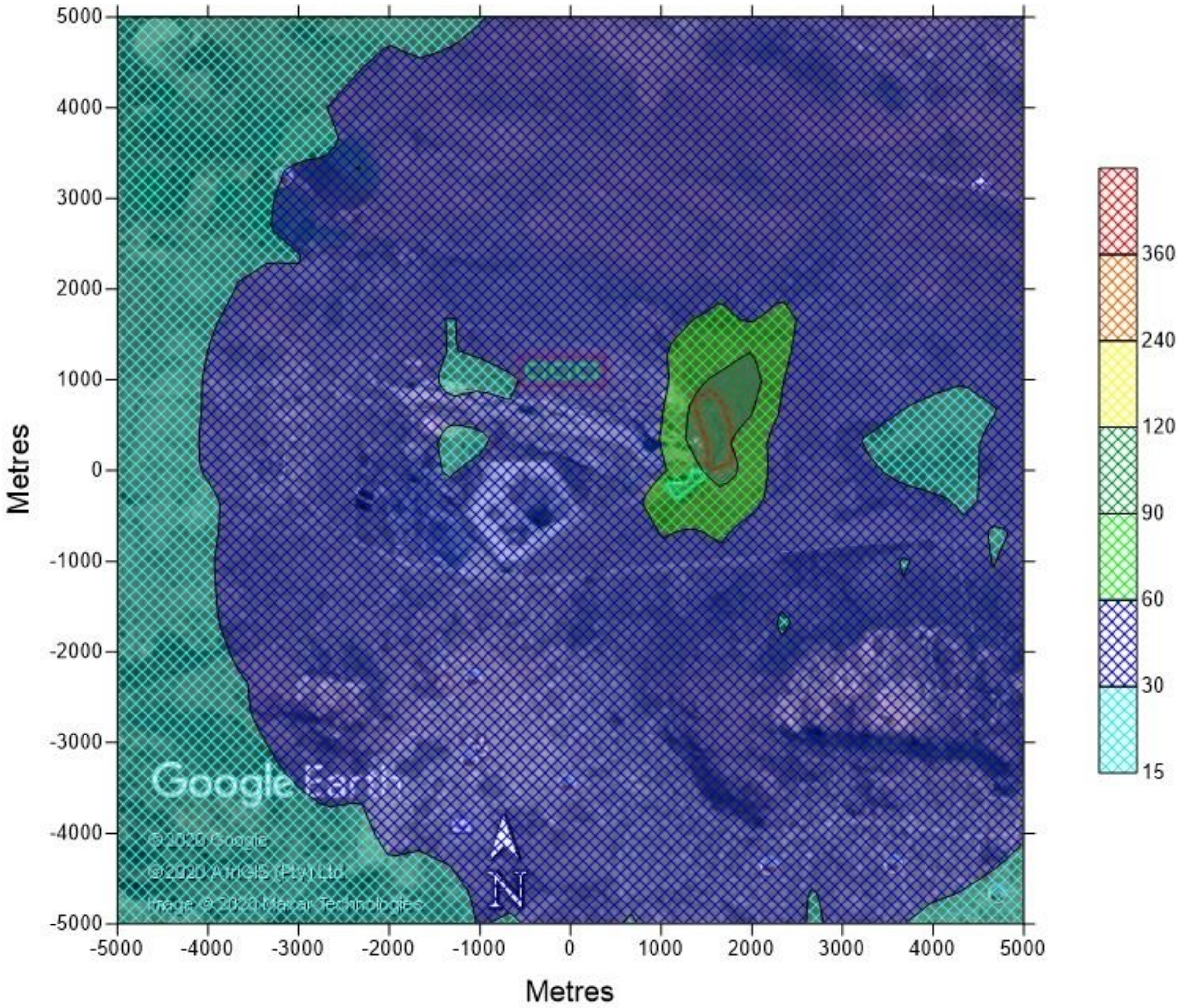


Figure 19: Modelled representation of incidences of the hundredth percentile of PM_{10} levels from fugitive emissions from Bushveld Vametco Alloys' proposed new installations, Alternative 1. Long term averages, 24 hour averaging period, levels indicated in µg/m^3

Moderate levels of dust may be experienced in the immediate vicinity of the dumps. Dustfall exceedences are not anticipated in neighbouring residential areas. These plumes do not intercept with sensitive receptor areas.

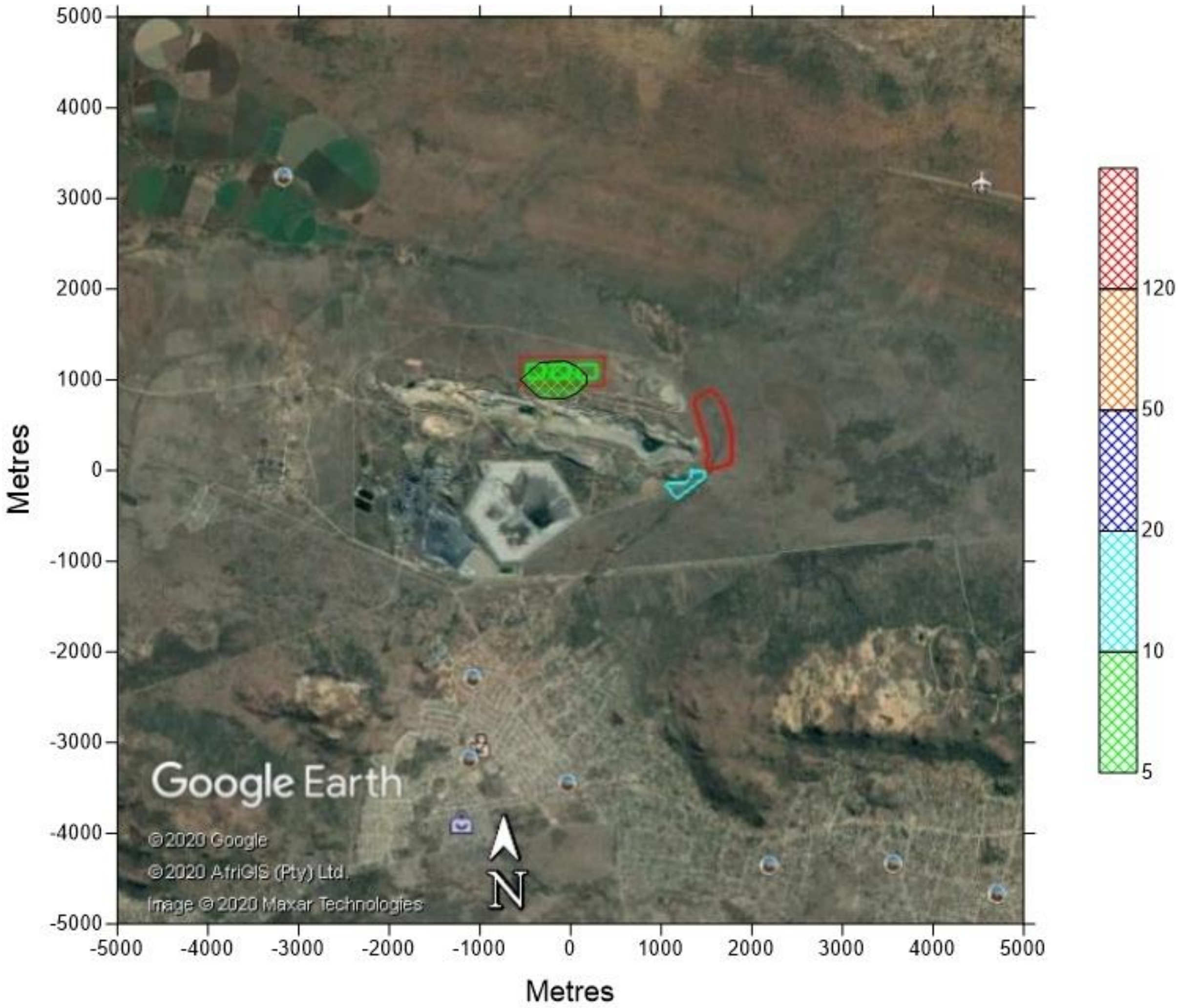


Figure 20: Modelled representation of current dust dispersion from fugitive emissions from Bushveld Vametco Alloys' proposed new installations, Alternative 2. Long term averages, 24 hour averaging period, levels indicated in µg/m^3

Dustfall is limited to the immediate vicinity of the waste dump.

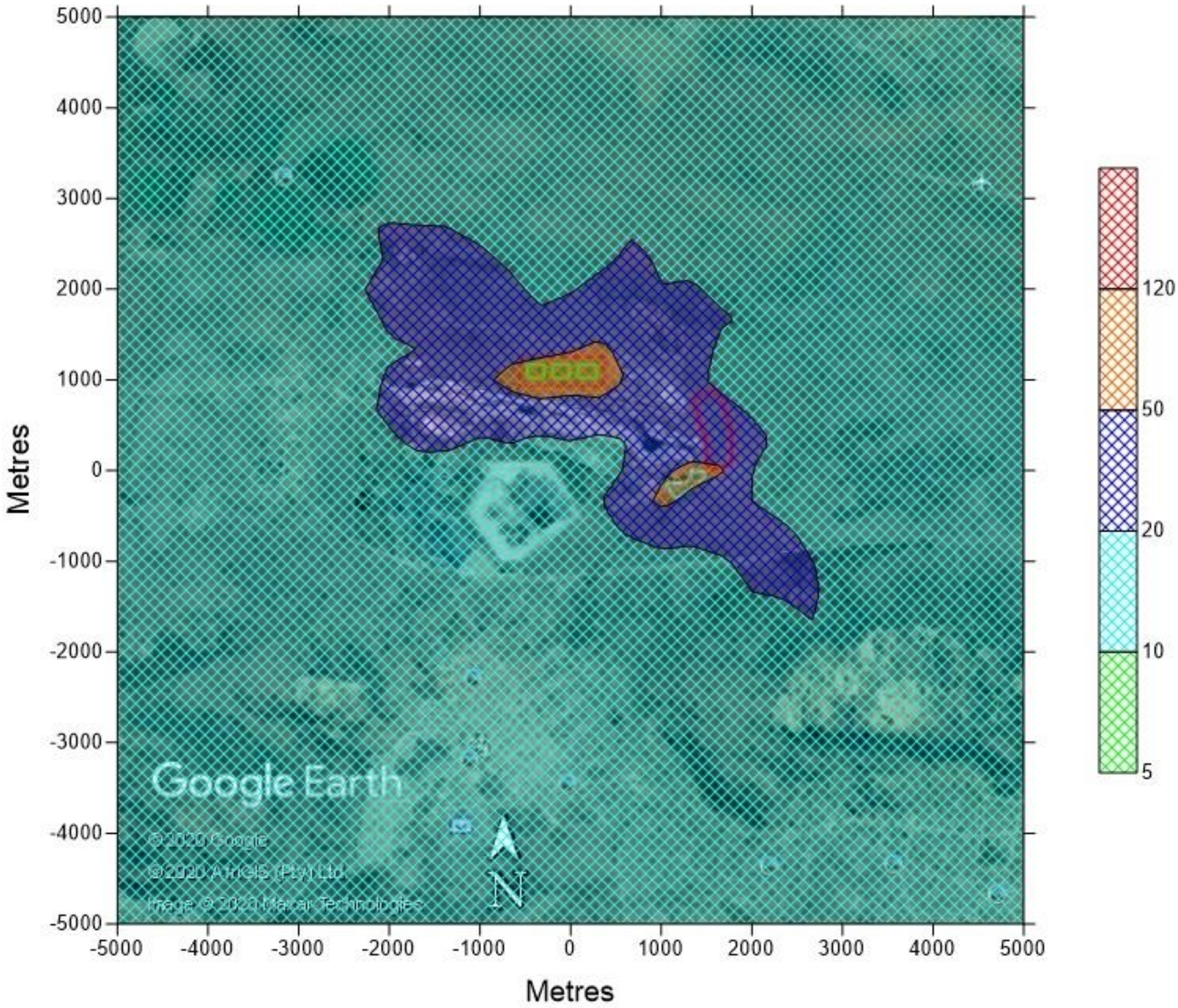


Figure 21: Modelled representation of incidences of the hundredth percentile of PM_{10} levels from fugitive emissions from Bushveld Vametco Alloys' proposed new installations, Alternative 1. Long term averages, 24 hour averaging period, levels indicated in µg/m^3

Moderate levels of dust may be experienced in the immediate vicinity of the dumps. Dustfall exceedences are not anticipated in neighbouring residential areas. These plumes do not intercept with sensitive receptor areas.

10.8.2 Judgment between alternative sites

There is no material difference between the sites from a dust dispersion point of view. If one site allows easier dust mitigation for whatever reason, that can be considered in the decision as to the appropriate site.

11. DETAILS OF SPECIALIST AND DECLARATION OF INTEREST

PROJECT TITLE

Bushveld Vametco Alloys – Air Quality report

Specialist:	Kijiji Kijani Environmental Consultants		
Contact person:	Simon Gear		
Postal address:	26 Fairbridge Rd, Roosevelt Park ext 1		
Postal code:	2195	Cell:	082 821 4975
Telephone:	082 821 4975	Fax:	-
E-mail:	simon@kijanigreen.co.za		
Professional affiliation (s) (if any)	NACA Pr. Nat. Sci		

Project consultant:	Nsovo Environmental Consultants		
Contact person:	Rejoice		
Postal address:	40 Lyncon Road, Carlswald, Midrand, 1684		
Postal code:		Cell:	
Telephone:	011 041 3689	Fax:	
E-mail:	rejoice@nsovo.co.za		

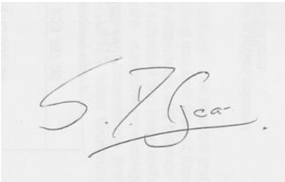
The specialist appointed in terms of the Regulations

I, Simon Gear, declare that

- I act as an independent specialist in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of

influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;

- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of section 24F of the Act.



Signature of the specialist:

Kijiji Kijani Environmental Consulting

Name of company (if applicable):

16 August 2019

Date:

12. IMPACTS

The bulk of the material ambient impacts from the BVA plant are associated with the combustion emissions of PM_{10}. Compliance modelling indicates that this scenario will improve materially once the plant undergoes the refitting necessary to limit these emissions and to bring the point source combustion emissions into spec with emissions standards.

Fugitive dust emissions may result from the expanded dumps but these should be easily mitigated with an appropriate dust management program.

12.1 Impact assessments

The following standardised impact assessment criteria is used:

Status of Impact
The impacts are assessed as either having a:
Negative effect (i.e. at a `cost' to the environment),
Positive effect (i.e. a `benefit' to the environment), or
Neutral effect on the environment.

Extent of the Impact
(**1**) Site (site only),
(**2**) Local (site boundary and immediate surrounds),
(**3**) Regional,
(**4**) National, or
(**5**) International.

Duration of the Impact
The length that the impact will last for is described as either:
(**1**) Immediate (<1 year)
(**2**) Short term (1-5 years),
(**3**) Medium term (5-15 years),
(**4**) Long term (ceases after the operational life span of the project),
(**5**) Permanent.

Magnitude of the Impact
The intensity or severity of the impacts is indicated as either:
(**0**) none,
(**2**) Minor,
(**4**) Low,
(**6**) Moderate (environmental functions altered but continue),
(**8**) High (environmental functions temporarily cease), or
(**10**) Very high / unsure (environmental functions permanently cease).

Probability of Occurrence

The likelihood of the impact actually occurring is indicated as either:
(**0**) None (the impact will not occur),
(**1**) Improbable (probability very low due to design or experience)
(**2**) Low probability (unlikely to occur),
(**3**) Medium probability (distinct probability that the impact will occur),
(**4**) High probability (most likely to occur), or
(5) Definite.

Significance of the Impact
Based on the information contained in the points above, the potential impacts are assigned a significance rating (**S**). This rating is formulated by adding the sum of the numbers assigned to extent (**E**), duration (**D**) and magnitude (**M**) and multiplying this sum by the probability (**P**) of the impact.
S= (E+D+M) P

The significance ratings are given below
(**<30**) low (i.e. where this impact would not have a direct influence on the decision to develop in the area),
(**30-60**) medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated), (**>60**) high (i.e. where the impact must have an influence on the decision process to develop in the area).

12.1.1 Combustion emissions

Issue	Corrective measures	Impact rating criteria					Significance
		Nature	Extent	Duration	Magnitude	Probability	
Dust missions associated with construction of combustion facilities, including site clearing	No	Negative	2	1	4	2	14 (Low)
	Yes	Negative	2	1	2	2	10 (Low)
Corrective actions	• Fugitive dust emissions associated with increased traffic to the site during construction. Corrective actions may include traffic speed control and spraying of surrounding roads to minimise dust impacts						
Combustion emissions associated with operation of plant	No	Negative	2	3	6	4	44 (Medium)
	Yes	Negative	2	3	2	4	28 (Low)
Corrective actions	• Installation of a new scrubber system at the rotary kiln • Installation of a new bag filter unit at the shaft furnaces						
Dust missions associated with decommissioning of combustion facilities	No	Negative	2	1	4	2	14 (Low)
	Yes	Negative	2	1	2	2	10 (Low)
Corrective actions	• Fugitive dust emissions associated with increased traffic to the site during decommissioning. Corrective actions may include traffic speed control and spraying of surrounding roads to minimise dust impacts						

12.1.2 Fugitive dust (all phases, including construction, operational and closure phases)

Issue	Corrective measures	Impact rating criteria					Significance
		Nature	Extent	Duration	Magnitude	Probability	
Fugitive dust	No	Negative	2	3	6	3	33 (Medium)
	Yes	Negative	2	3	4	3	27 (Low)
Corrective actions	• Minimise materials handling (operational efficiency) • Encourage vegetation on dumps • Spray haul roads • Wind breaks upwind of dumps • Cover fine material • Speed control on haul roads						

13. CONCLUSION

Following the analysis presented above, it seems clear that any air quality impacts associated with this expansion can be adequately managed.

It is this consultant's opinion that the AEL be amended accordingly, with the necessary monitoring and abatement requirements expected by the competent authority put in place.