Waste ASIDE
"Our Clean Future Environment"

REPORT – AIR QUALITY IMPACT ASSESSMENT FOR AFRIMAT WOLVE KOP QUARRY

Report: WA-01-WLVK

July 2021

Prepared For

AFRIMAT – WOLVE KOP QUARRY

Prepared by:

Waste Aside

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EXECUTIVE SUMMARY

Afrimat Aggregates (Pty) Ltd, appointed Waste Aside CC to conduct an Air Quality Impact Assessment for the Wolve Kop Operation. Afrimat Aggregates Operations (Pty) Ltd, a subsidiary of Afrimat is proposes for a applying for a mining permit to mine 4.9ha of Remaining Extent of Portion 13 of farm 12 Wolve Kop situated in Middelburg RD Magisterial District, Eastern Cape Province. The site is located 22km North of Noupoort and 14km South of Midros. These will all be open cast operations where quarrying will take place through utilising a bench cut method. The material which will be mined is Dolerite best suited for the lower aggregates such as sub-base and base gravel road wearing roads.

The quarrying will entail opening of the surface through open cast mining methods. The applicant will:

1. Drill and blast the hard rock after the topsoil of the area has been stripped and stockpiled,
2. Load and haul the material out of the excavation to the crushing and screening plants,
3. Crush and screen the recovered material at the crusher plant in order to reduce it to various size aggregate,
4. Stockpile the aggregate at a stockpile area until it is collected by clients.

The air quality impact assessment undertaken for the project includes a meteorological overview of the area. An emissions inventory was undertaken with the aim of quantifying emissions associated with the activities involved in the mining of coal. The emissions for specific activities such as bulldozing, blasting, tipping, wind erosion and materials handling activities were calculated and the cumulative impacts were compared to the relevant ambient air quality standards to determine legal compliance.

The findings reported here is therefore a combination of historical, observed and previously modelled data and provided the background and predicted scenario of various pollutants in the Afrimat Wolve Kop project mining area. The construction and operational phases were assessed. Based on the dispersion modelling simulations, the following conclusions can be summarized as follows:

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The findings reported here is therefore a combination of historical, observed and previously modelled data and provided the background and predicted scenario of various pollutants in the Afrimat Wolve Kop project mining area. The construction and operational phases were assessed. Based on the dispersion modelling simulations, the following conclusions can be summarized as follows:

PM_{10}

For the unmitigated and mitigated Daily PM_{10} concentrations it was predicted not to be higher than the 75 µg/m³ limit for any of the sensitive receptors.

The annual average PM_{10} limit of 40 µg/m³ are not predicted to exceed at any of the identified sensitive receptors for any of the modelled scenarios.

TSP

In the mitigated and unmitigated scenarios none of the sensitive receptors are predicted to exceed the monthly dust fallout for the highest month residential limit of 600 mg/m²/day.

The predicted annual dust fall out for the mitigated and unmitigated scenarios are not predicted to exceed the annual limit of 300 mg/m²/day at any of the sensitive receptors.

Recommendations

Based on the results presented the following further recommendations are outlined:

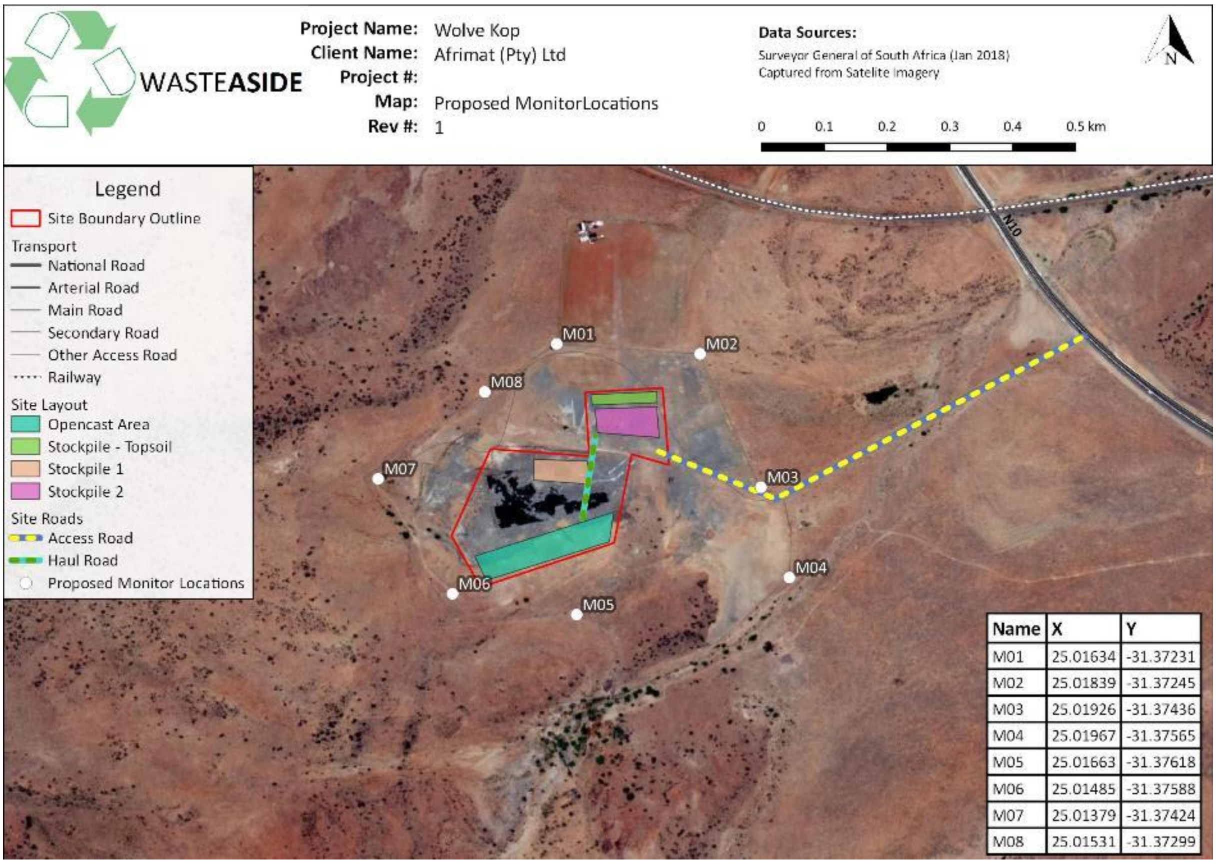
- Fallout monitoring should be established to include all 8 compass directions.
- Fallout monitoring is to be continued for the life of mine to better assess the level of nuisance dust associated with both mining and process related operations. Sampling of fallout should be undertaken within the neighbouring areas as well as on-site. Dust fallout monitoring is recommended at the locations as shown in Figure 22.
- PM_{10} and $PM_{2.5}$ dust monitoring must also be undertaken at the same sites as mentioned under the previous bullet but also in and around potential fugitive emission sources to determine mitigation measures and focus management efforts.

Further mitigation measures that should be applied, if it is found that dust and PM_{10} levels are measured to be exceeding the limits are:

- Fully sealed Pit and Access Haul Roads to achieve 90-100% mitigation on these roads.

The impacts from dust fallout and Particulate matter can be reduced by implementing dust control measures. The highest intensity of the construction work should be carried out during the summer months and not over the harsh winter months as can result in increased dispersion of fugitive dust. The mine should ensure that unpaved roads are continuously watered and treated with dust binding additive products to reduce the volume of fugitive dust emitted from unpaved roads.

The mitigation and management measures for mining operation and discussed in this report should be sufficient to ensure the mining operation can be conducted with minimal impact on the receiving environment and therefore not have a detrimental effect and can go ahead.



Name	X	Y
M01	25.01634	-31.37231
M02	25.01839	-31.37245
M03	25.01926	-31.37436
M04	25.01967	-31.37565
M05	25.01663	-31.37618
M06	25.01485	-31.37588
M07	25.01379	-31.37424
M08	25.01531	-31.37299

Figure 1 Proposed Monitor Locations

1. INTRODUCTION

Afrimat Aggregates (Pty) Ltd, appointed Waste Aside CC to conduct an Air Quality Impact Assessment for the Wolve Kop Operation. Afrimat Aggregates Operations (Pty) Ltd, a subsidiary of Afrimat is proposes for a applying for a mining permit to mine 4.9ha of Remaining Extent of Portion 13 of farm 12 Wolve Kop situated in Middelburg RD Magisterial District, Eastern Cape Province. The site is located 22km North of Noupoort and 14km South of Midros., see attached KMZ files and locality maps). These will all be open cast operations where quarrying will take place through utilising a bench cut method. The material which will be mined is Dolerite best suited for the lower aggregates such as sub-base and base gravel road wearing roads.

The quarrying will entail opening of the surface through open cast mining methods. The applicant will:

1. Drill and blast the hard rock after the topsoil of the area has been stripped and stockpiled,
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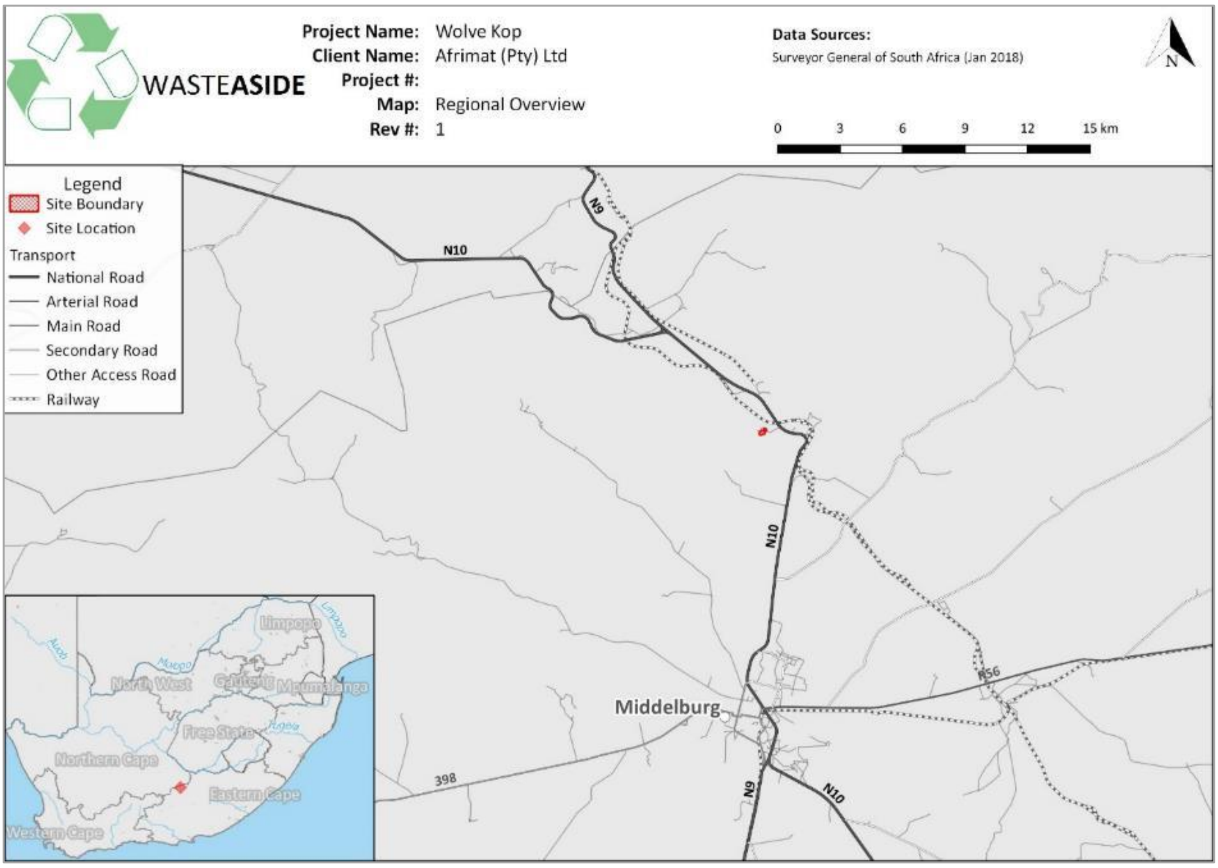


Figure 2: Map indicating the regional overview of the proposed Afrimat Wolve Kop project.

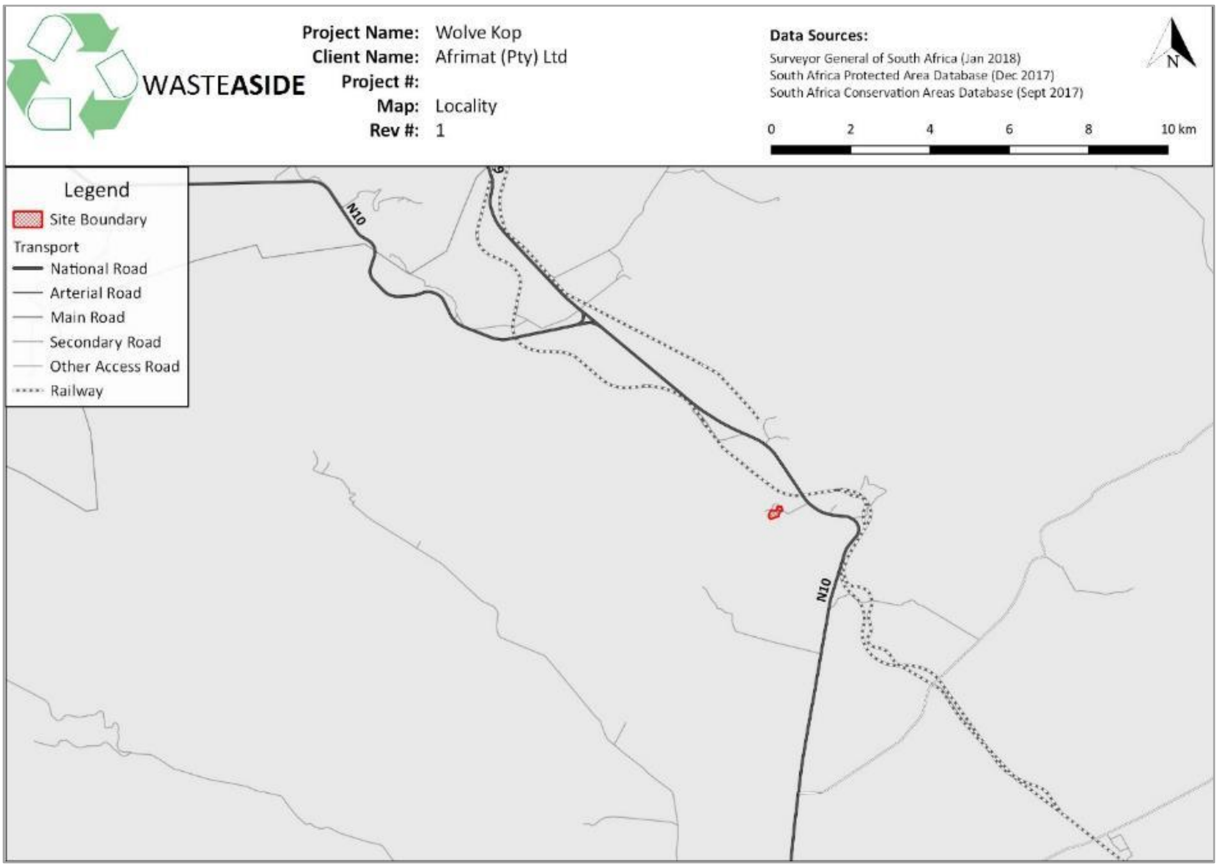


Figure 3: Locality map of the proposed Afrimat Wolve Kop project.

2. SCOPE OF WORK

The purpose of this study is to:

1. Study the available information relevant to the current ambient air quality pollution concentrations in the environment;
2. Identify the major existing air emission sources in the environment;
3. Identify the existing sensitive air pollution areas in the environment;
4. Estimate by means of measurements and integration of the results with those of any relevant existing information the present ambient air quality climate;
5. Identify the mining related processes and equipment that will cause the major contribution to the future air quality impact;
6. Consider, evaluate and rate the potential air quality impacts; and
7. Propose relevant management and mitigation measures to lessen the anticipated impacts

3. STUDY AREA

Industries

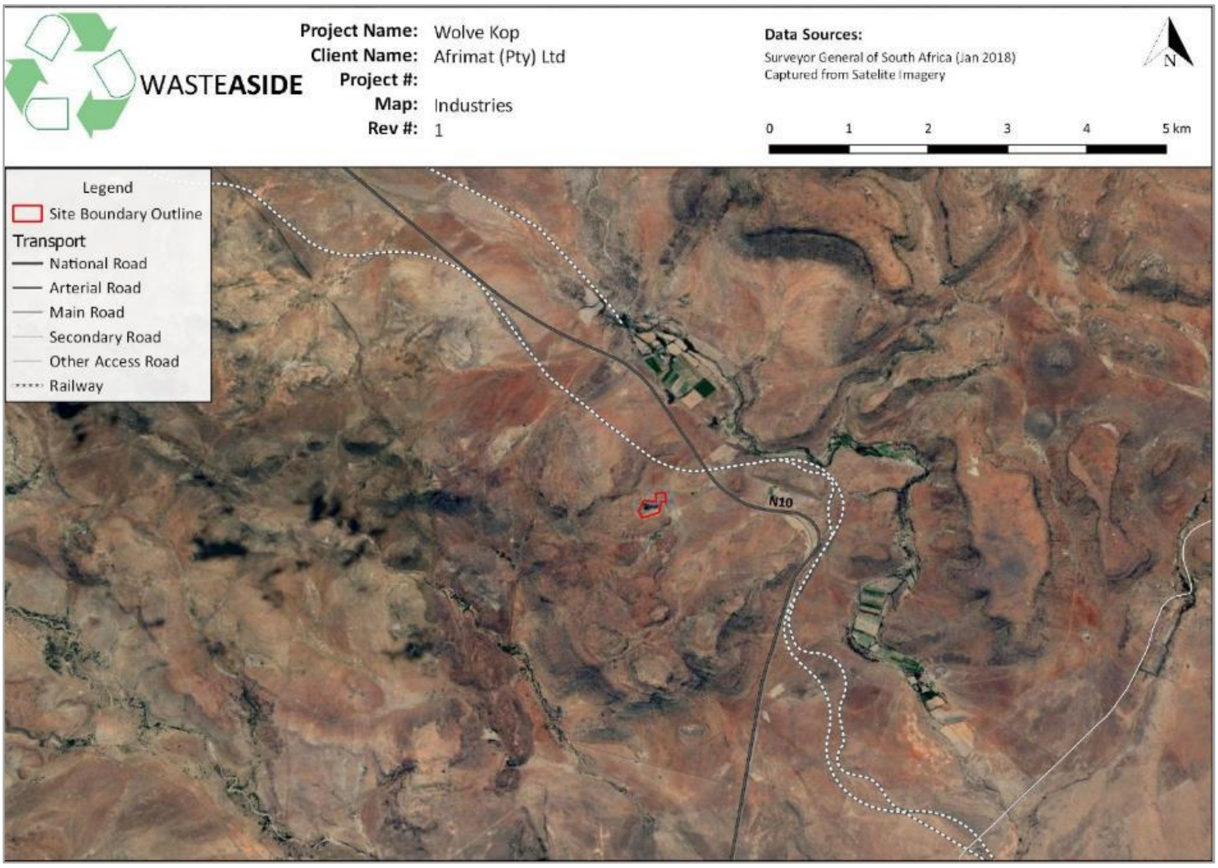


Figure 4: Other industries in the immediate vicinity of the proposed Afrimat Wolve Kop project.

From a desktop study of satellite imagery, no other industrial operations could be identified in the immediate vicinity of the proposed Wolve Kop Project.

Population

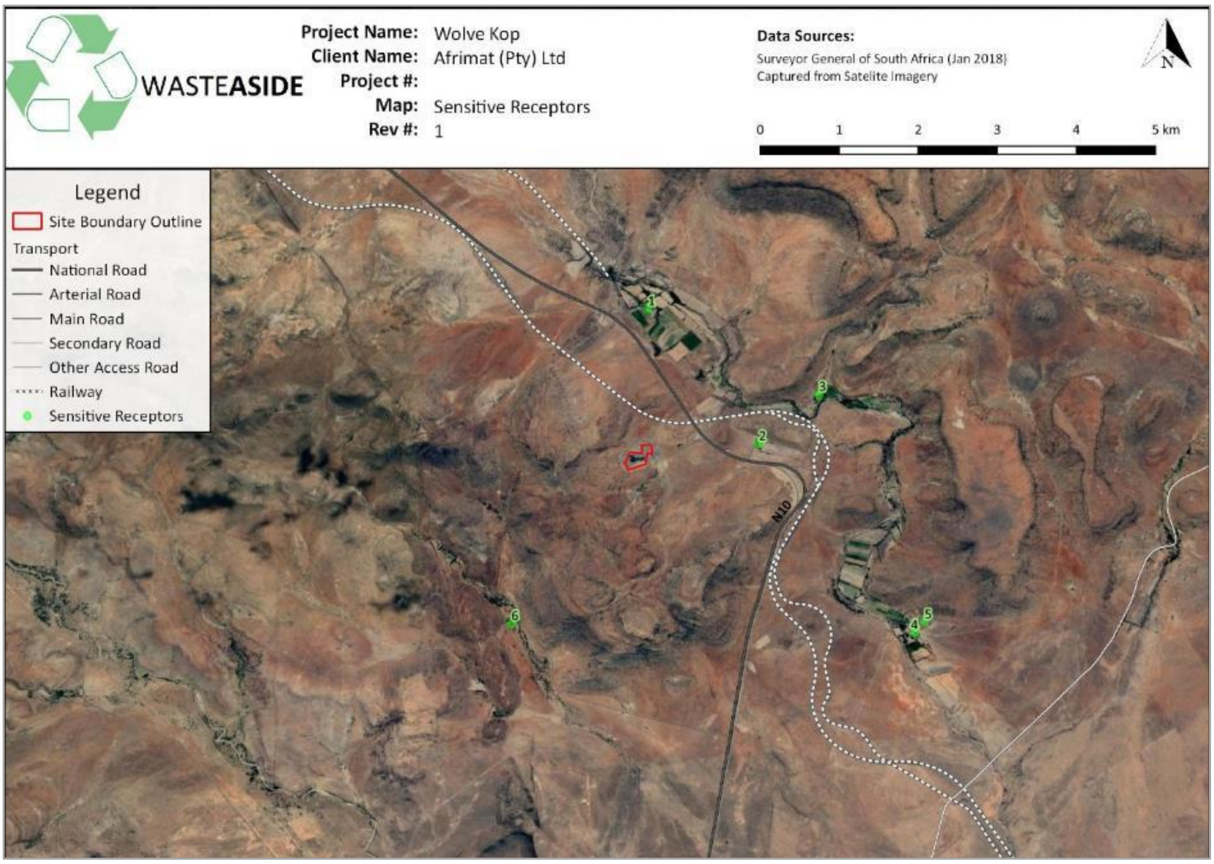


Figure 5: Population areas within the immediate vicinity of the proposed Afrimat Wolve Kop project.

From a desktop study of satellite imagery various sensitive receptors in the form farmhouses surrounding the proposed operations have been identified. It should be noted that the sensitive receptors in the area may differ from those identified as not all areas may have been identified from the imagery successfully.

Topography

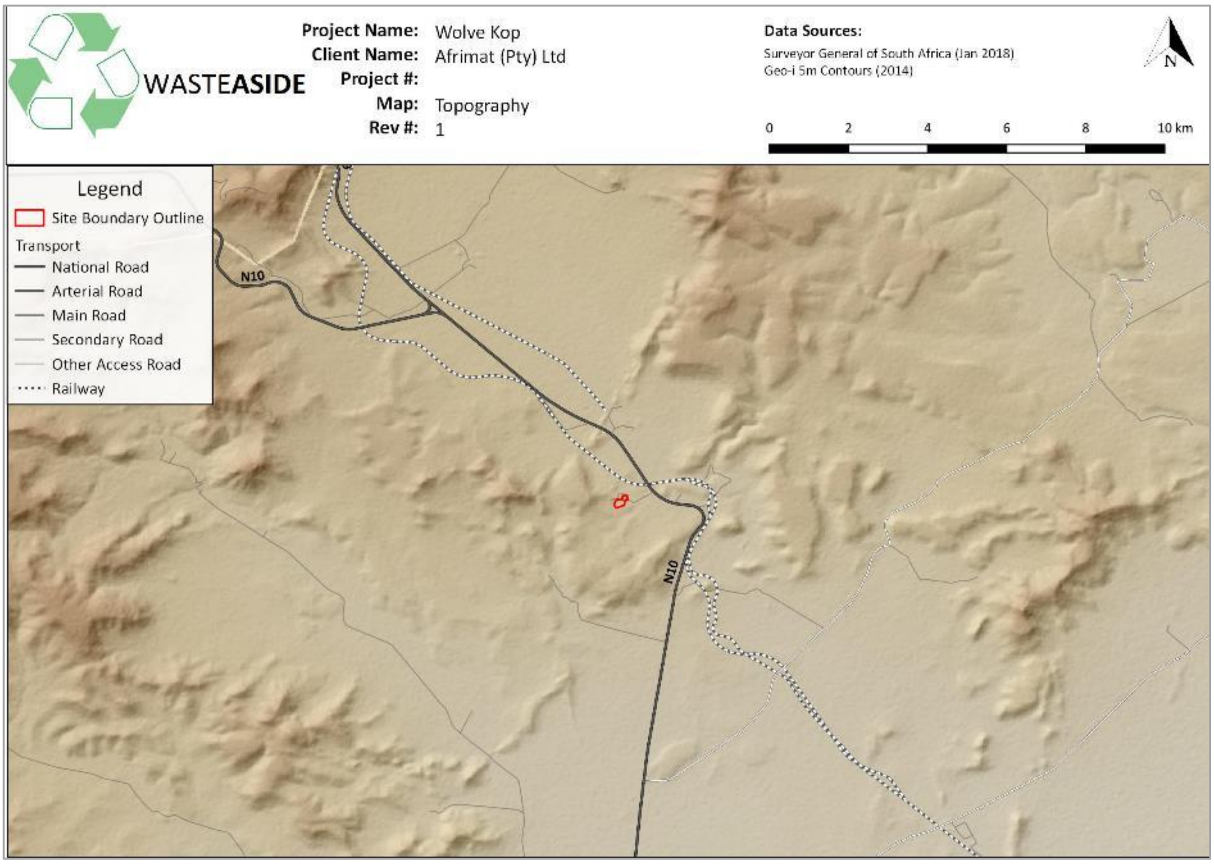


Figure 6: 3D map showing the terrain relief of the area around the proposed Afrimat Wolve Kop project.

The proposed Afrimat Wolve Kop project area is situated on hilly terrain as can be seen in Figure 6 above. No major topographical features can be found in the immediate vicinity.

4. METEOROLOGICAL DATA

Regional Air Quality

South Africa is located in the sub-tropics where high pressures and subsidence dominate. However, the southern part of the continent can serve as a source of hot air that intrudes sub-tropics, and that sometimes lead to convective movement of air masses. On average, a low pressure will develop over the southern part of the continent, while the normal high pressures will remain over the surrounding oceans. These high pressures are known as Indian High-Pressure Cells and Atlantic High-pressure Cells. The intrusion of continents will allow for the development of circulation patterns that draw moisture (rain) from either tropic (hot air masses over equator) or from the mid-latitude and temperate latitudes.

Southern Africa is influenced by two major high-pressure cells, in addition to various circulation systems prevailing in the adjacent tropical and temperate latitudes. The mean circulation of the atmosphere over Southern Africa is anticyclonic throughout the year (except near the surface) due to the dominance of the three high pressure cells, namely South Atlantic High Pressure, off the west coast, the South Indian High Pressure off the east coast and the Continental High Pressure over the interior.

It is these climatic conditions and circulation movements that are responsible for the distribution and dispersion of air pollutants within the proposed Afrimat Wolve Kop Project area and between neighbouring provinces and countries bordering South Africa.

Meso-Scale Meteorology

The nature of the local climate will determine what will happen to the pollution when it is released into the atmosphere (Tyson and Preston-Whyte, 2000). Pollution levels fluctuate daily and hourly, in response to changes in atmospheric stability and variations in mixing depth. Similarly, atmospheric circulation patterns will have an effect on the rate of transport and dispersion of pollution.

The release of atmospheric pollutants into a large volume of air results in the dilution of those pollutants. This is best achieved during conditions of free convection and when the mixing layer is deep (unstable atmospheric conditions). These conditions occur most frequently in summer during the daytime. This dilution effect can however be inhibited under stable atmospheric conditions in the boundary layer (shallow mixing layer). Most surface pollution is thus trapped under a surface inversion (Tyson and Preston-Whyte, 2000).

Inversion occurs under conditions of stability when a layer of warm air is situated directly above a layer of cool air. This layer prevents a pollutant from diffusing freely upward, resulting in an increased pollutant concentration at or close to the earth's surface. Surface inversions develop under conditions of clear, calm and dry conditions and often occur at night and during winter (Tyson and Preston- Whyte, 2000). Radiative loss during the night results in the development of a cold layer of air close to the earth's surface. These surface inversions are however, usually destroyed as soon as the sun rises and warm the earth's surface. With the absence of surface inversions, the pollutants are able to diffuse freely upward; this upward motion may however be prevented by the presence of an elevated inversion (Tyson and Preston-Whyte, 2000).

Elevated inversions occur commonly in high pressure areas. Sinking air warms adiabatically to temperatures in excess of those in the mixed boundary layer. The interface between the upper, gently subsiding air is marked by an absolutely stable layer or an elevated subsidence inversion. This type of elevated inversions is most common over Southern Africa (Tyson and Preston-Whyte, 2000).

The climate and atmospheric dispersion potential of the interior of South Africa is determined by atmospheric conditions associated with the continental high-pressure cell located over the interior. The continental high-pressure present over the region in the winter months results in fine conditions with little rainfall and light winds with a northerly flow. Elevated inversions are common in such high-pressure areas due to the subsidence of air. This reduces the mixing depth and suppresses the vertical dispersion of pollutants, causing increased pollutant concentrations (Tyson and Preston- Whyte, 2000).

Seasonal variations in the positions of the high-pressure cells have an effect on atmospheric conditions over the region. For most of the year the tropical easterlies cause an air flow with a north-easterly to north-westerly component. In the winter months the high-pressure cells move northward, displacing the tropical easterlies northward resulting in disruptions to the westerly circulation. The disruptions result in a succession of cold fronts over the area in winter with pronounced variations in wind direction, wind speeds, temperature, humidity, and surface pressure.

Airflow ahead of a cold front passing over the area has a strong north-north-westerly to north-easterly component, with stable and generally cloud-free conditions. Once the front has passed, the airflow is reflected as having a dominant southerly component (Tyson and Preston-Whyte, 2000).

Easterly and westerly wave disturbances cause a southerly wind flow and tend to hinder the persistence of inversions by destroying them or increasing their altitude, thereby facilitating the dilution and dispersion of pollutants. Pre-frontal conditions tend to reduce the mixing depth. The potential for the accumulation of pollutants during pre-frontal conditions is therefore enhanced over the plateau (Tyson and Preston-Whyte, 2000).

Site-Specific Dispersion Potential

A period wind rose for the site is presented in Figure 8 below. Wind roses comprise of 16 spokes which represents the direction 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 direction categories.

Based on an evaluation of the meteorological data simulations run from a global NEMS weather model at ~30 km resolution from 1985 to current of the project area. The following deductions regarding the prevailing wind direction and wind frequency can be assessed. Looking at Figure 8 below, the predominant wind direction is predicted to occur mainly from the south-east more than 1220 hours per year, with wind speeds higher than 5 km/h.

At the site, calm conditions with wind speeds of 12 km/h or less, are predicted 3-7 days per month throughout the year. 12-19 km/h winds are predicted 6-11 days per month through the year. Wind speeds of more than 19 km/h are predicted to occur 9-13 days per year on average.

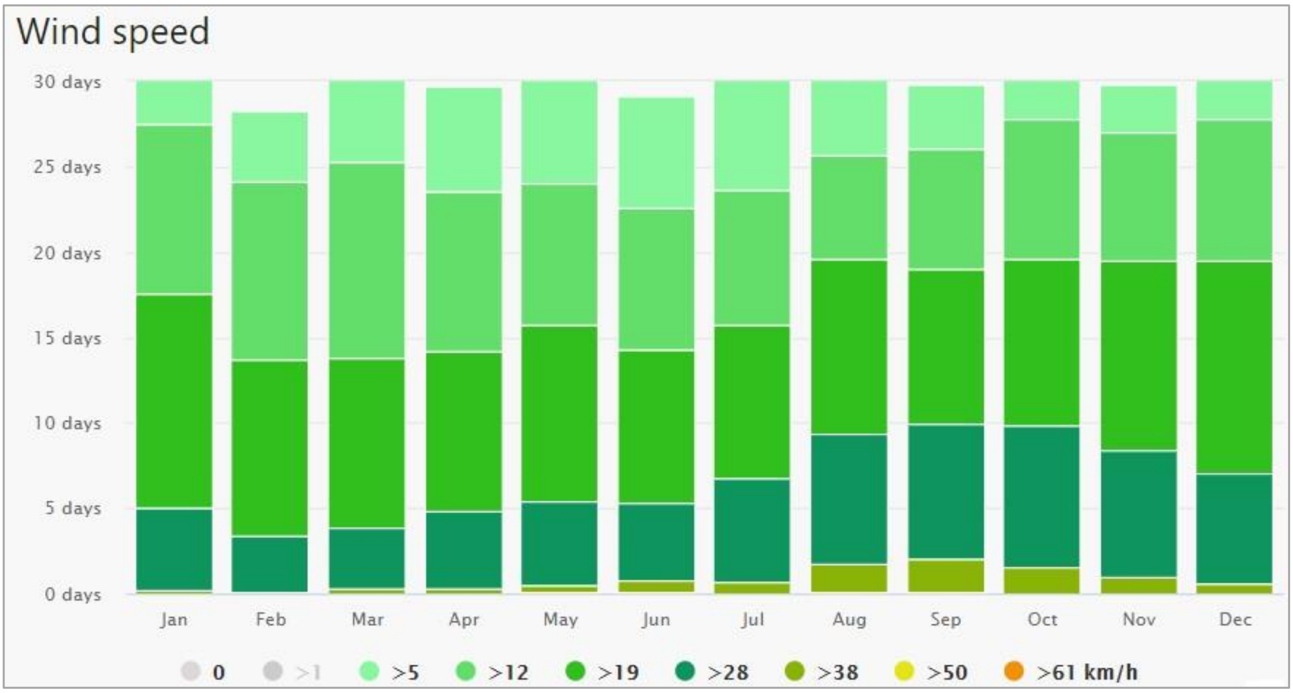


Figure 7: Wind Class Frequency Distribution per month.

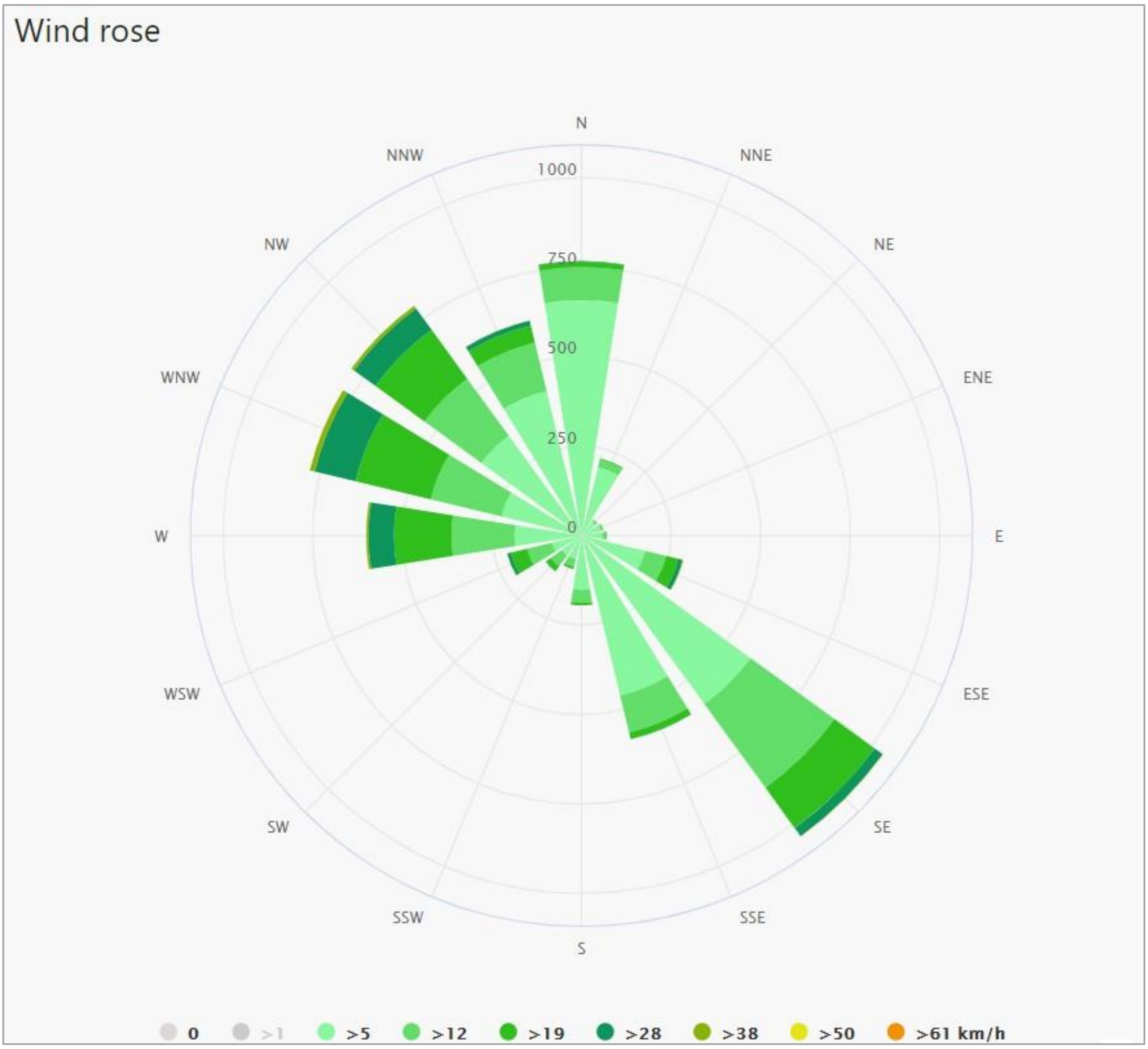


Figure 8: NEMS 30 km simulation model wind rose for the proposed Afrimat Wolve Kop project area for the period 1985 to current.

Atmospheric Stability

The tendency of the atmosphere to resist or enhance vertical motion and thus turbulence is termed atmospheric stability. Stability is related to both the change of temperature with height and wind speed. A neutral atmosphere neither enhances nor inhibits mechanical turbulence. An unstable atmosphere enhances turbulence, whereas a stable atmosphere inhibits mechanical turbulence. The turbulence of the atmosphere is the most important parameter affecting dilution of air pollution as the more unstable the atmosphere, the greater the dilution of air pollution.

Atmospheric stability is commonly categorized into six stability classes as per Table 1 below. The atmospheric boundary layer is usually unstable during the day due to turbulence caused by the sun's heating effect on the earth's surface. The depth of this mixing layer depends mainly on the amount of solar radiation, increasing in size gradually from sunrise to reach a maximum at about 5 - 6 hours after sunrise. The degree of thermal turbulence is increased on clear warm days with light winds. During the night-time a stable layer, with limited vertical mixing, exists. During windy and/or cloudy conditions, the atmosphere is normally neutral.

Table 1:Atmospheric Stability Classes

A	Very unstable	calm wind, clear skies, hot daytime conditions
B	Moderately unstable	clear skies, daytime conditions
C	Unstable	moderate wind, slightly overcast daytime conditions
D	Neutral	high winds or cloudy days and nights
E	Stable	moderate wind, slightly overcast night-time conditions
F	Very stable	low winds, clear skies, cold night-time conditions

A neutral atmospheric potential neither enhances nor inhibits mechanical turbulences. Unstable atmospheric condition enhances turbulence, whereas stable conditions inhibit mechanical turbulence.

Temperature

Temperature affects the formation, action, and interactions of pollutants in various ways (Kupchella and Hyland, 1993). Chemical reaction rates tend to increase with temperature and the warmer the air, the more water it can hold and hence the higher the humidity. When relative humidity exceeds 70%, light scattering by suspended particles begins to increase, as a function of increased water uptake by the particles (CEPA/FPAC Working Group, 1999). This results in decreased visibility due to the resultant haze. Many pollutants may dissolve in water to form acids. Temperature also provides an indication of the rate of development and dissipation of the mixing layer.

Based on an evaluation of the meteorological data simulations run from the global NEMS weather model at ~30 km resolution from 1985 to current of the project area. The following deductions can be made; In the summer months' maximum average daily temperatures are predicted to be 22°C to 29°C on average with a maximum of 35°C possible during hot days, dropping to a predicted 9°C to 14°C on average at night and 1°C minimum on cold nights. During winter months the average day time temperature are predicted in the 14°C to 21°C range while cold winter night time temperatures predicted to drop to -5°C.

Falling in a summer rainfall area, the location is predicted to receive the most precipitation in the summer months of October to April overall. December to January are predicted the highest rainfall months with between 28 mm to 41 mm predicted per month during these months. October and November is predicted to receive 28 mm precipitation. All other months are predicted to receive less than 13 mm precipitation on average during the month.

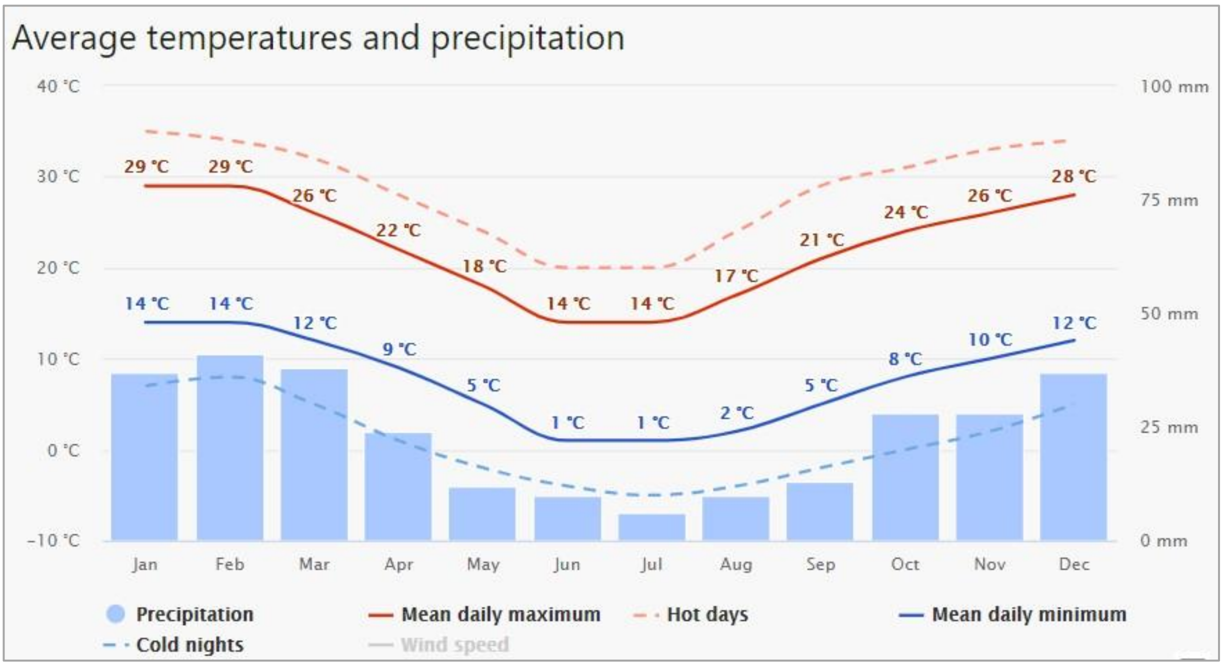


Figure 9: Temp and precipitation simulation results from the NEMS model for the Afrimat Wolve Kop project area (1985 - current).

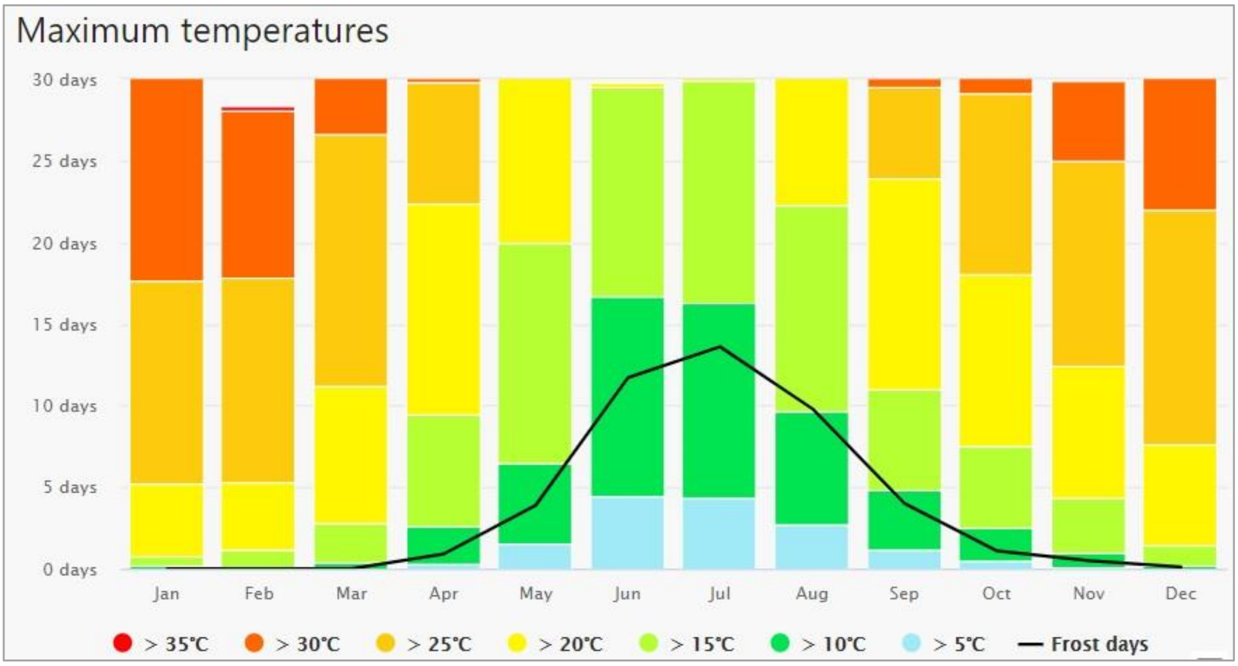


Figure 10: Maximum temperatures as simulated from the NEMS 30 km model for the proposed Afrimat Wolve Kop project area (1985 – current).

Precipitation

Precipitation cleanses the air by washing out particles suspended in the atmosphere (Kupchella & Hyland, 1993). It is calculated that precipitation accounts for about 80-90% of the mass of particles removed from the atmosphere (CEPA/FPAC Working Group, 1999). The total precipitation predicted at the Afrimat Wolve Kop project area is shown in Figure 11 below.

The highest precipitation days are predicted during the months of October to April. During these months' precipitation is predicted to only occur 6 to 10 days on average. The rest of the year precipitation is predicted to occur less than 3 days per month.

Figure 11: Day count of total daily precipitation per month for the proposed Afrimat Wolve Kop project area for the period 1985 – current.

Wind Speed, Temperature and Precipitation Validation

To validate the NEMS model simulation results, only weather stations with more than 10 years' consistent data are considered for validation. The validation is thus not necessarily the closest station with actual measured data but rather the closest reliable station. The measurements from the chosen station is then aggregated on a weekly or monthly data. Figure 12 below show the closest station to the Afrimat Wolve Kop project area that fall within the validation criteria as stated above, in this case Noupoort, 22 km away and at a similar altitude. The recorded data show good correlation in respect to temperature and wind speed. Precipitation also show good correlation to the modelled data.

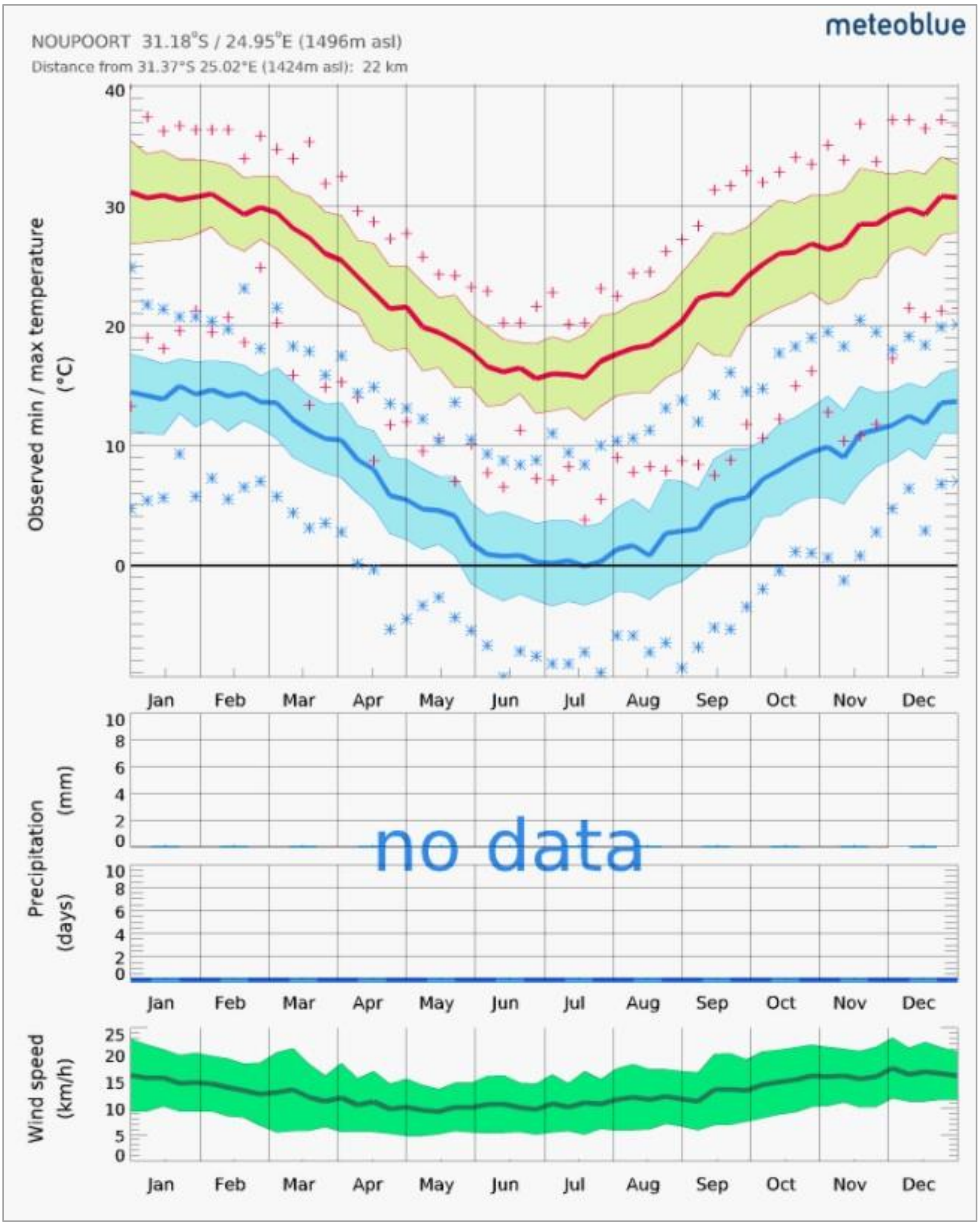


Figure 12: Measurement data for the closest measurement location with enough data to verify the NEMS model result.

5. RELEVANT LEGISLATION, GUIDELINES AND STANDARDS

National Environmental Management: Air Quality, 2004 (Act 39 Of 2004)

The National Environmental Management: Air Quality Act 39 of 2004 shifted the approach of air quality management from source-based control to receptor-based control. The Act made provision for National ambient air quality standards, however it is generally accepted that more stringent standards can be established at the Provincial and Local levels. Emissions are controlled through the listing of activities that are sources of emission and the issuing of emission licences for these listed activities. Atmospheric emission standards have been established for each of these activities and an atmospheric licence is now required to operate.

The issuing of emission licences for Listed Activities will be the responsibility of the Metropolitan and District Municipalities. Municipalities are required to 'designate an Air Quality Officer to be responsible for co-ordinating matters pertaining to air quality management in the Municipality'. The appointed Air Quality Officer will be responsible for the issuing of atmospheric emission licences or the Air Quality Officer could delegate the responsibility to the Director of Community Environmental Services.

According to the Act, 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.
- National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) - National Dust Control Regulations (Government Gazette No. 36794 - No. R 827)

The National Dust Control Regulations, published on 1 November 2013, in terms of the National Environmental Management Air Quality Act, which prescribes general measures for the control of dust.

Table 2: Dust Fallout permitted rates

Restriction Areas	Dust Fall Rate (mg/m³/day - 30 day average)	Permitted Frequency of exceeding dust fall rate
Residential Areas	D < 600	2 within a year, not sequential months
Non-Residential Area	600 < D < 1200	2 within a year, not sequential months

According to regulations, any person conducting any activity in such a way that would give rise to dust in quantities and concentrations that exceeded the dust fall standard set out in the regulation was impelled to, upon receipt of a notice from an air quality officer, implement a dust fall monitoring programme.

The method to be used for measuring the dust fall rate and the guideline for locating sampling points would be the American Standards for Testing and Materials method, or an equivalent method approved by any internally recognized body.

The regulation further stated that an Air Quality Officer could require any person, through a written notice, to undertake a dust fall monitoring programme if the officer reasonably suspected that the person was contravening the regulations or that the activity being conducted required a fugitive dust emission management plan. A person required to implement the programme must then, within a specified period, submit a dust fall monitoring report to the air quality officer. A dust fall monitoring report must provide information on the location of sampling sites, classification of the area where samplers were located, as well as reference to the standard methods used for site selection, sampling and analysis.

The report would also be required to provide meteorological data for the sampling area, the dust fall monitoring results, including a comparison of current year and historical results for each site, as well as a tabular summary of compliance with the dust fall standard. Any person that had exceeded the dust fall standard must, within three months after submission of the dust fall monitoring report, develop and submit a dust fall management plan to the Air Quality Officer for approval. This management plan must identify all possible sources of dust within the affected site, detail the best practicable measures to be undertaken to mitigate dust emissions, identify the line management responsible for implementation and incorporate the dust fallout monitoring plan. Such a plan would need to be implemented within a month of the date of approval and an implementation progress report must be submitted to the Air Quality Officer at agreed time intervals.

Legislation for Local Government

The Local Government: Municipal Systems Act 32 of 2000, together with the Municipal Structures Act 117 of 1998, establishes local government as an autonomous sphere of government with specific powers and functions as defined by the Constitution. Section 155 of the Constitution provides for the establishment of Category A, B and C municipalities each having different levels of municipal executive and legislative authorities. According to Section 156(1) of the Constitution, a municipality has the executive authority in respect of, and has the right to, administer the local government matters (listed in Part B of Schedule 4 and Part B of Schedule 5) that deal with air pollution.

Ambient Air Quality Guidelines and Standards

Guidelines provide a basis for protecting public health from adverse effects of air pollution and for eliminating, or reducing to a minimum, those contaminants of air that are known or likely to be hazardous to human health and well-being (WHO, 2000). Once the guidelines are adopted as standards, they become legally enforceable. The South African Bureau of Standards (SABS), in collaboration with DEA, established ambient air quality standards for gravimetric dust fallout and is listed in the

Table 3 below.

Table 3, show the published PM_{10} limits. Table 4 and Table 5 below show the dust deposition evaluation scale and threshold levels respectively.

Table 3: Limits for PM_{10} in ug/m³

Average period	Concentration (µg/m³)	Frequency of exceedances
Target		
24 h	75	4
1 year	40	0

Table 4: Four-band scale evaluation criteria for dust deposition in mg/m²/day

Band Number	Band Description Label	Dust Fall Rate (mg/m²/day - 30 day average)	Comment
1	Residential	D < 600	Permissible for residential and light commercial.
2	Industrial	D < 1200	Permissible for heavy commercial and industrial.
3	Action	1200 < D < 2400	Requires investigation and remediation if two sequential months lie in this band, or more than three occur in a year.
4	Alert	D > 2400	Immediate action and remediation required following the first incidence of the dustfall rate being exceeded. Incident report to be submitted to the relevant authority.

Table 5: Target, action and alert thresholds for dust deposition in mg/m²/day

Level	Dust Fall Rate (mg/m²/day - 30 day average)	Average Period	Permitted frequency of exceeding dustfall rate
Target	300	Annual	
Action Residential	600	30 days	2 within any year, no 2 sequential months
Action Industrial	1 200	30 days	2 within any year, not sequential months
Alert Threshold	2 400	30 days	None. First incidence of dust fall rate being exceeded requires remediation and compulsory report to the relevant authorities.

6. METHODOLOGY

Passive Sampling

At the time of this report, no passive sampling campaign do exist for the Afrimat Wolve Kop project. It is highly recommended that a passive sampling campaign be established that include the 8 main compass directions. Below are the features of a passive sampling campaign:

At each gravimetric dust fallout gauge/receptor point there is a stand built according to specification containing the dust sample collection bucket. Samples are collected after a 1 month running period (+-30 day's exposure). After sample collection, the samples are taken to the relevant SANAS accredited laboratory as required. A visual site investigation is done where after correlations are drawn and findings identified and reported on.

Dust buckets of a standard size and shape are prepared and set up at locations related to the eight main compass points on the borders of the property so that dust can settle in them for periods of 30 +/-2 days. The dust buckets are then sealed and replaced with new empty ones and send away to the SANAS accredited laboratory for analysis. The masses of the water-soluble and –insoluble components of the material collected are then determined and results are reported as mg/m²/day. This methodology is described according to South African National Standards 1929:2004 and the American Society for Testing and Materials (ASTM) Designation: D 1739-98 (2010). The results for this method of testing are obtained by gravimetrical weighing. The apparatus required include open top buckets/containers not less than 150 mm in diameter with a height not less than twice its diameter. The buckets must be placed on a stand at a height of 2 +/-0.2 m above the ground.

Dispersion Model

Emission factors are quantified using the Australian National Pollutant Inventory (NPI) which is an improvement on the US Environmental Protection Agency (US.EPA) AP-42 document of Air Pollution Emission Factors for Australian conditions, for fugitive dust deriving from material handling, on-site roads, milling and crushing operations, drilling and blasting, and wind erosion from exposed surfaces. Various mitigation measures were incorporated into the project design as discussed in the emission factor section.

Dispersion models represents the most likely outcome of experimental results; it does not contain all the features of a real-world system but contain the feature of interest for management of an issue. Gaussian plume models have an uncertainty range of between -50% to 200%.

There will always be some error in any geophysical model, the total uncertainty can be described as the sum of three components:

- Uncertainty due to errors in the model physics;
- Uncertainty due to data errors; and
- Uncertainty due to the atmospheric conditions.

Model Selection

Increasing reliance has been placed on estimates from models as the primary basis for environmental and health impact assessments. It is therefore important to carefully select a dispersion model for the purpose. Dispersion models compute ambient concentrations as a function of source configurations, and meteorological characteristics, providing a tool to calculate the spatial and temporal patterns in the ground level concentrations arising from the emissions of emissions sources.

Gaussian-plume models are best used for near-field applications where the steady-state meteorology assumption is most likely to apply. The most widely used Gaussian plume model is the US.EPA AERMOD model.

The regulatory model of the US.EPA, AERMET/AERMOD dispersion model suite, was chosen for the study. AERMET uses both surface and upper air data. The model also has a terrain pre-processor (AERMAP) for including a large topography into the model. The AERMET/AERMOD suite was developed with the support of the AMS/EPA Regulatory Model Improvement Committee (AERMIC), whose objective was to include state-of the-art science in regulatory models.

- AERMOD is an advanced new-generation model. It is designed to predict pollution concentrations from continuous point, flare, area, line, and volume sources.

- AERMET is a meteorological pre-processor for AERMOD. Input data can come from hourly cloud cover observations, surface meteorological observations and twice-a-day upper air soundings.

Output includes surface meteorological observations and parameters and vertical profiles of several atmospheric parameters.

- AERMAP is a terrain pre-processor designed to simplify and standardise the input of terrain data for AERMOD. Input data includes receptor terrain elevation data which are used for the computation of air flow around hills.

A disadvantage of the model is the range of uncertainty of the model predictions could to be -50% to 200% and spatial varying wind fields, due to topography or other factors cannot be included. The accuracy of the model improves with fairly strong wind speeds and during neutral atmospheric conditions.

The stochastic uncertainty includes all errors or uncertainties in data such as source variability, observed concentrations, and meteorological data. Model evaluation studies suggest that the data input error term is often a major contributor to total uncertainty. Even in the best tracer studies, the source emissions are known only with an accuracy of ±5%, which translates directly into a minimum error of that magnitude in the model predictions. It is also well known that wind direction errors are the major cause of poor agreement, especially for relatively short-term predictions (minutes to hourly) and long downwind distances. All of the above factors contribute to the inaccuracies not associated with the mathematical models themselves.

Input data required for the AERMOD model include:

- Source emissions and type data;
- Meteorological data (pre-processed by the AERMET model);
- Terrain data; and
- The receptor grid.

Meteorological Data

AERMOD requires two specific input files generated by the AERMET pre-processor. AERMET is designed to be run as a three-stage processor and operates on three types of data (upper air data, on-site measurements, and the national meteorological database).

Use was made of the WRF, MMIF processed weather data for the period 1 January 2018 to 31 December 2020.

Source Data

AERMOD is able to model point, area, volume, pit and line sources. Wind erosion sources such as stockpiles, and unpaved roads modelled as area sources. Material transfer points and crushing and screening were modelled as volume sources. With the input sources using pit retention factors applied to the emission as described in the Australian NPI.

Sensitive Receptor Grid

The pollutant dispersion is setup for a modelled domain of 10 km (north-south) by 10 km (east-west) with the center of the proposed project area in the center of the modelling domain. The area was divided into a grid of 100m x 100m.

Modelling Runs

Modelling was undertaken for the operational phase scenarios.

1. Un-mitigated;
2. Mitigated – Sources as Specified.

The construction and decommissioning phases were qualitatively assessed.

Modelling Results

Dispersion modelling was undertaken to determine 2nd highest daily and annual average ground level concentrations (GLCs) for PM_{10} Total daily dust fallout rates were also simulated. These averaging periods are selected to draw comparisons between PM_{10} predicted concentrations / deposition with relevant air quality guidelines and dust fallout limits, respectively.

Isopleths plots are also generated, for the preferred scenario, to visually display the interpolated values from the concentrations predicted by the model for each of the receptor grid points. Plots reflecting daily averaging periods contain only the 2nd highest predicted ground level concentrations for the daily concentration, over the entire period for which simulations were undertaken. It is therefore possible that even though a high hourly or daily average concentration is predicted at certain locations, this may only be true for one day during the modelling period.

7. DISPERSION MODEL

Emissions Inventory

Table 6 below describes the through put rates on which the calculations were based. In the quantification of the emissions the emission factor equations published by the US.EPA as well as the NPI compiled by the Australian Government.

Table 6: Modelling Parameter Summary

Project Specific Information			
Type	Spec	Quantity	Unit
Material	ROM	8 333	tpm
Operations	Hours	9	
	Days	21	
Haul Road	Width*	9	m
	Length	0.75	km
Access Road	Width*	9	m
	Length	0.13	km
Haul Trucks - ROM	Type	Bell B40D	
	Height	4.2	m
	Width	3.8	m
	Payload	37	t
	Trips	2.38	per h

Project Specific Information			
	VKT	0.31	per h
Commercial Trucks	Type		
	Height*	3.1	m
	Width*	2.6	m
	Payload	30	t
	Trips	2.94	per h
	VKT	2.2	per h
Note:	** Assumed*		

Table 7: NPI Emission Factors

NPI Emission Factors				
Operation	TSP	PM_{10}	Units	Rating
Handling, transferring, and conveying including wheel and bucket reclaimers (except bauxite)	0.06	0.03	Kg/t	U
Wind Erosion	0.4	0.2	kg/ha/h	U
Haul Road	4.23	1.25	kg/VKT	B
Primary Crushing	0.2	0.02	kg/t	U
Screening	0.08	0.06	Kg/t	
Note:	Controlled = Water Sprays used			

Mitigation Measures

Mitigation measures proposed are discussed below.

Opencast Pit

50% mitigation on the various operations can be achieved using water sprays according to the Australian NPI.

Crusher

Crushing represents significant dust-generating sources. Dust fallout in the vicinity of crushers increase the potential for re-entrainment of dust by vehicles or wind. The large percentage of fines in the deposited material enhances the potential for it to become airborne. According to the Australian NPI, dust generation at Crushers can be mitigated by 50% with water sprays to keep the ore wet. When using hooding with fabric filters emissions can be reduced by 83%.

Material Handling

According to the Australian NPI, dust generation from material transfer points can be reduced by 50% where water sprays are applied. Adding wind break can reduce the dust emissions with 30%. Enclosing the operations, the emissions will become insignificant.

Stockpile

Wind erosion from stockpiles can be mitigated by 50% using water sprays according to the Australian NPI. Revegetation of stockpiles can bring 90% mitigation.

Total enclosure of the stockpiles can mitigate erosion by 99%. (Also, from the Australian NPI.)

Vegetal cover retards erosion by binding the residue with a root network, by sheltering the residue surface and by trapping material already eroded. Vegetation is considered the most effective control measure in terms of its ability to control water erosion. In investigating the feasibility of vegetation types the following properties are normally taken into account: indigenous plants; ability to establish and regenerate quickly; proven effective for reclamation elsewhere; tolerant to the climatic conditions of the area; high rate of root production; easily propagated by seed or cuttings; and nitrogen-fixing ability.

The long-term effectiveness of suitable vegetation selected for the site will be dependent on (a) the nature of the cover, and (b) the availability of aftercare. The Department of Minerals and Energy in Western Australia in its Guidelines on the Safe Design and Operating Standards for Tailings Storages (1996), for example, stipulates a covering of a minimum of 500 mm of suitable waste rock, followed by a layer of topsoil (or growth medium) and subsequent seeding. According to these guidelines all external surfaces should have a self-generating cover compatible with the surrounding environment.

Haul Road

For haul roads the Australian NPI indicate that dust emissions can be mitigated by 50% for level 1 watering (2 litres/m^2/h) or 75% for level 2 watering (>2 litres/m^2/h).

Sealing the road or salt-encrusted roads can mitigate 100% according to the Australian NPI.

The roads on-site were identified as the second most significant source of dust emissions. Three types of measures may be taken to reduce emissions from unpaved roads:

- measures aimed at reducing the extent of unpaved roads, e.g. paving,
- traffic control measures aimed at reducing the entrainment of material by restricting traffic volumes and
- measures aimed at binding the surface material or enhancing moisture retention, such as wet suppression and chemical stabilization (EPA, 1987; Cowhert *et al.*, 1988; APCD, 1995).

Given the indication that unsurfaced roads would be watered, control efficiencies which may be achieved through wet suppression were investigated. In addition, the reduction in vehicle entrainment due to reduced vehicle kilometres travelled are also included.

Permanent improvements in travel surfaces, such as the paving of a road, results in continuous control efficiencies. The control efficiencies obtained by wet suppression and the use of chemical stabilizers are, however, cyclic rather than continuous by nature as indicated previously. The efficiency afforded by the application of water or chemicals decay over time, requiring periodic reapplication to maintain the desired average efficiency (Cowherd et al., 1988). The following empirical model for the estimation of the average control efficiency of watering, developed by the US-EPA (EPA, 1996), can be applied in the estimation of control efficiencies achievable by unpaved road watering programmes:

$$C = 100 - (\frac{0.8pdt}{i})$$

Where,

c = average control efficiency (%)

d = average hourly daytime traffic rate (hr-1)

i = application intensity (litres per m2)

t = time between applications (hr)

p = potential average hourly daytime evaporation rate (mm/hr)

Table 8: Calculated Source Emission Rates Summary

Emissions Released								
	Unmitigated			Mitigated				
Operation	TSP	PM_{10}	Unit	TSP	PM_{10}	Unit	Reduction	Method
1.470	0.735	g/s	0.367	0.349	g/s	50%	Water Sprays and Pit Retention	1.470
1.11E-05	5.56E-06	g/s/m²	5.56E-06	2.78E-06	g/s/m²	50%	Water Sprays	1.11E-05
4.05E-05	1.20E-05	g/s/m²	1.01E-05	2.99E-06	g/s/m²	75%	Level 2 Watering (>2 liters/m²/h)	4.05E-05
2.88E-04	8.51E-05	g/s/m²	7.20E-05	2.13E-05	g/s/m²	75%	Level 2 Watering (>2 liters/m²/h)	2.88E-04
2.450	0.245	g/s	1.225	0.122	g/s	50%	Controlled	2.450
0.980	0.735	g/s	0.490	0.367	g/s	50%	Controlled	0.980

Modelling Results

Only the following scenario is plotted as this is considering the preferred scenario considering the result from the air quality model.

1. Un-mitigated;
2. Mitigated – Sources as Specified.

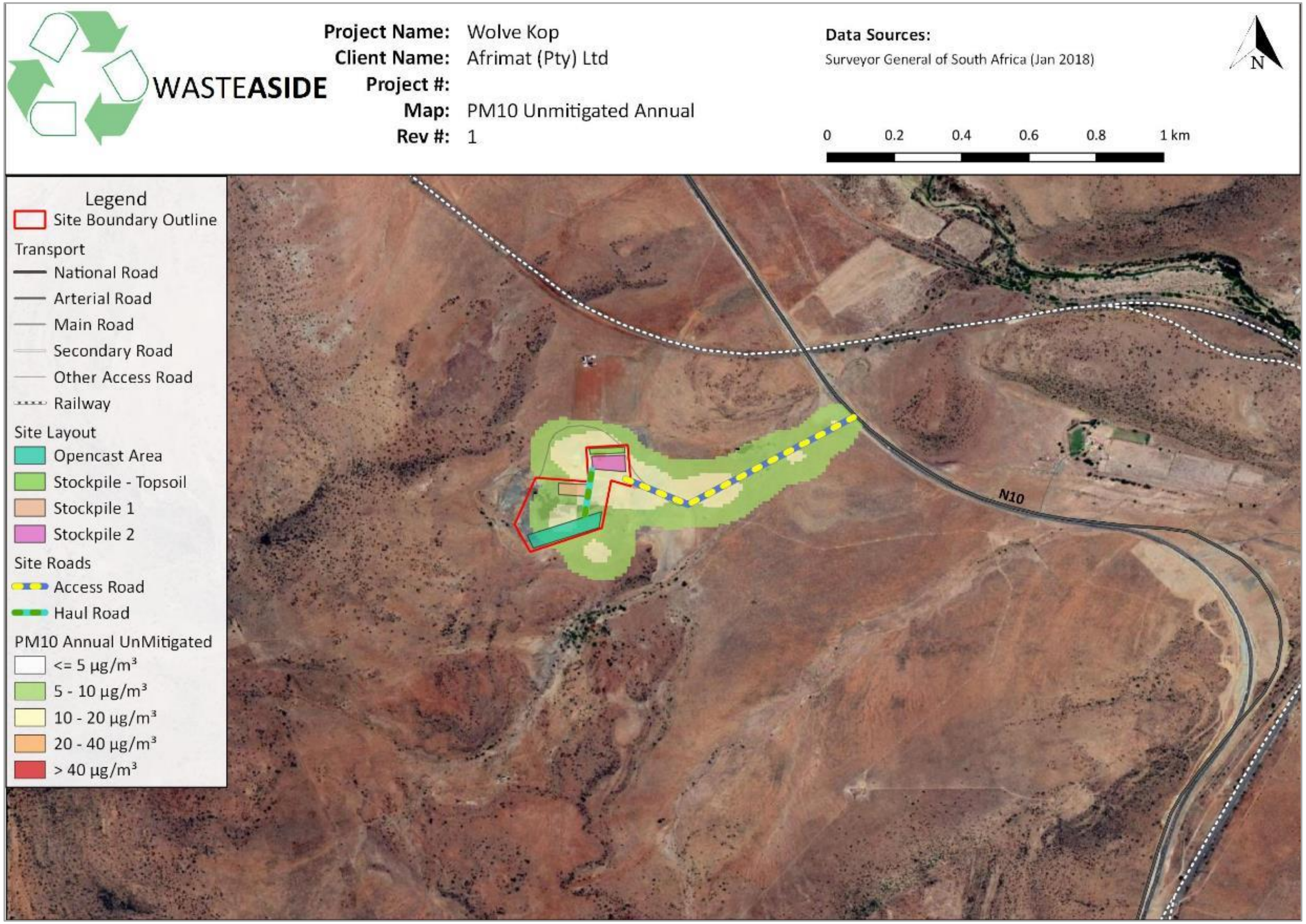


Figure 13: Predicted average annual concentrations for PM_{10} for the Afrimat Wolve Kop project when unmitigated.

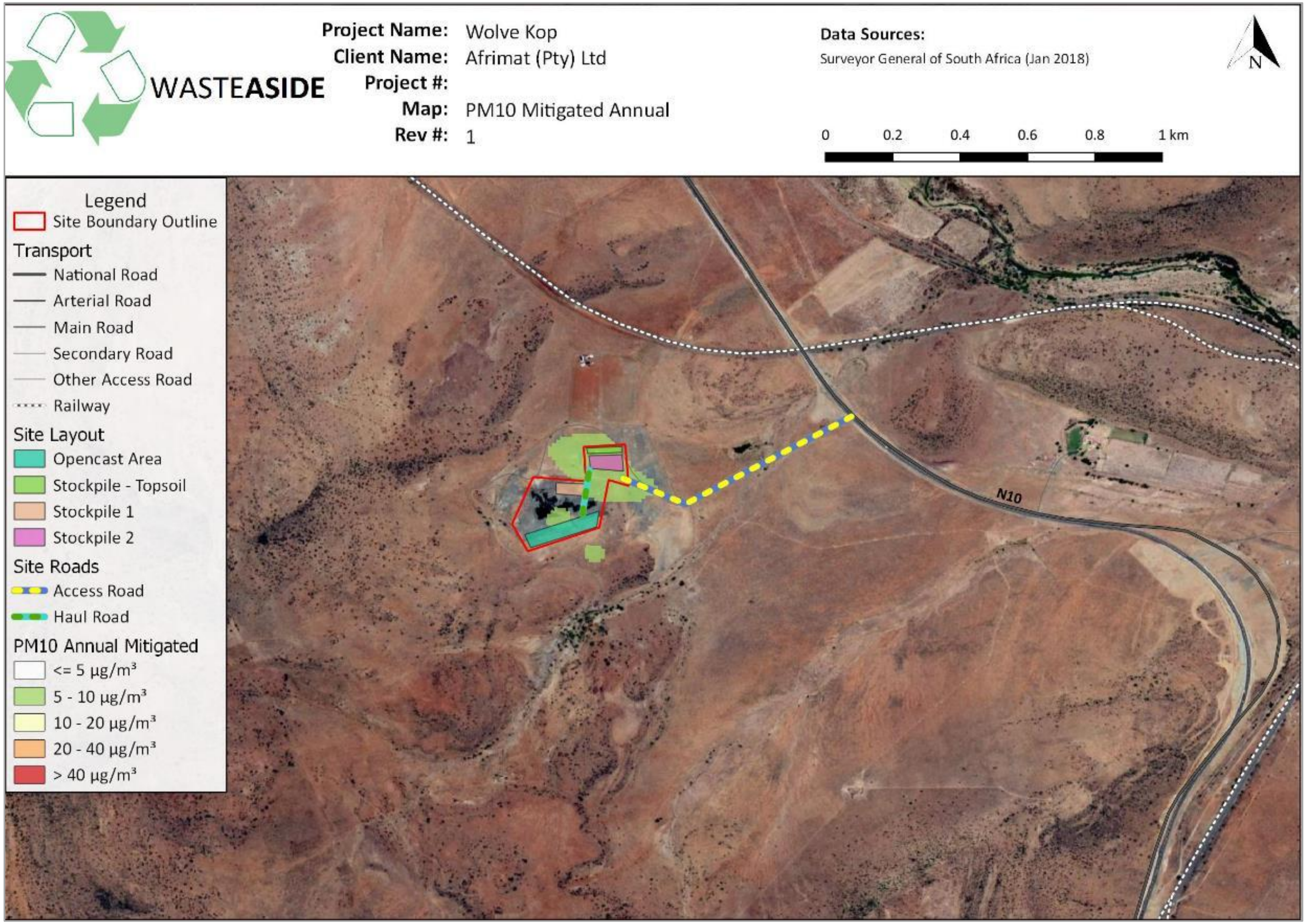


Figure 14: Predicted average annual concentrations for PM_{10} for the Afrimat Wolve Kop project operations when mitigated.

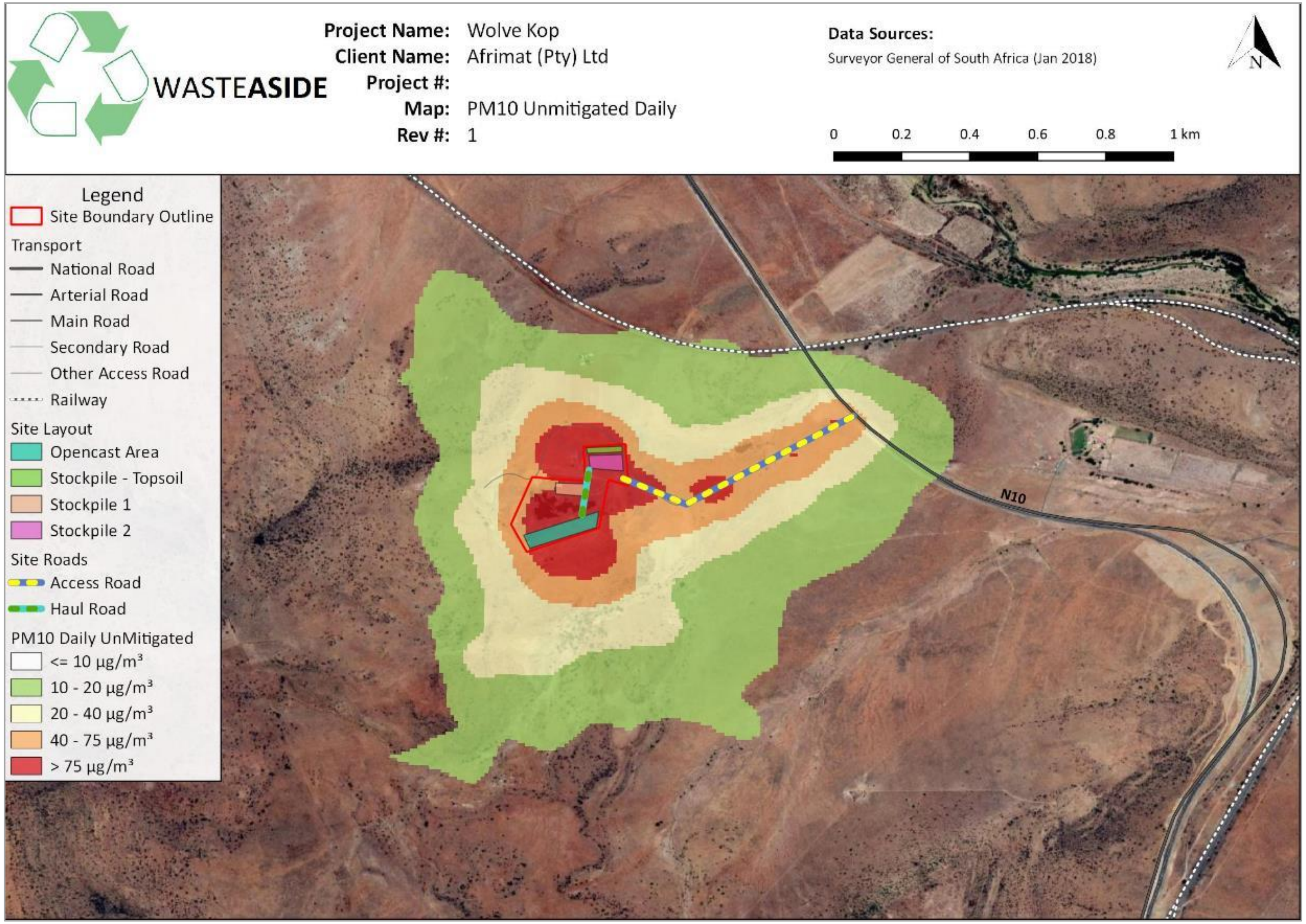


Figure 15: Predicted 2nd Highest daily concentrations for PM_{10} for the Afrimat Wolve Kop project operations when unmitigated.

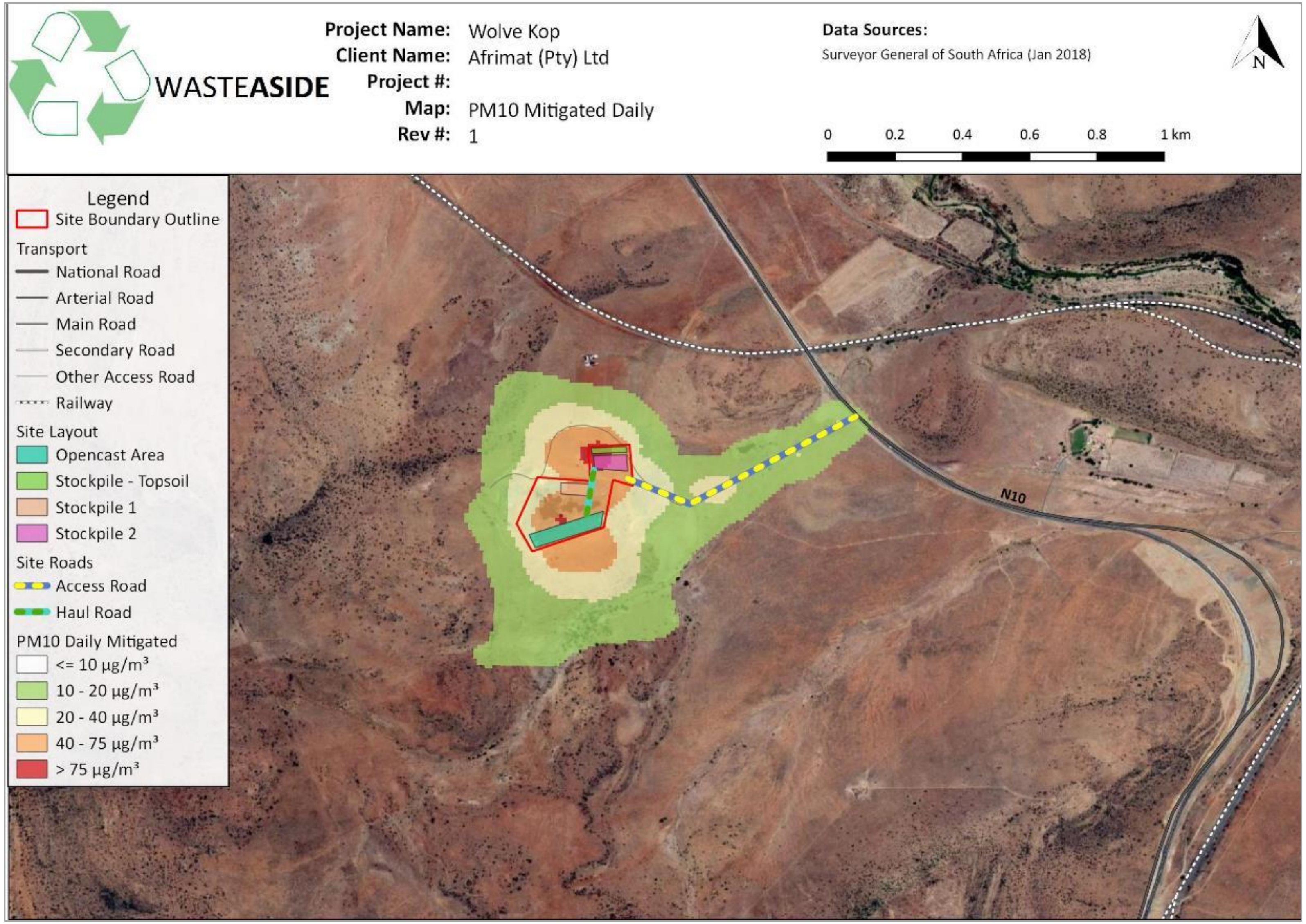


Figure 16: Predicted 2nd Highest daily concentrations for PM_{10} for the Afrimat Wolve Kop project operations when mitigated

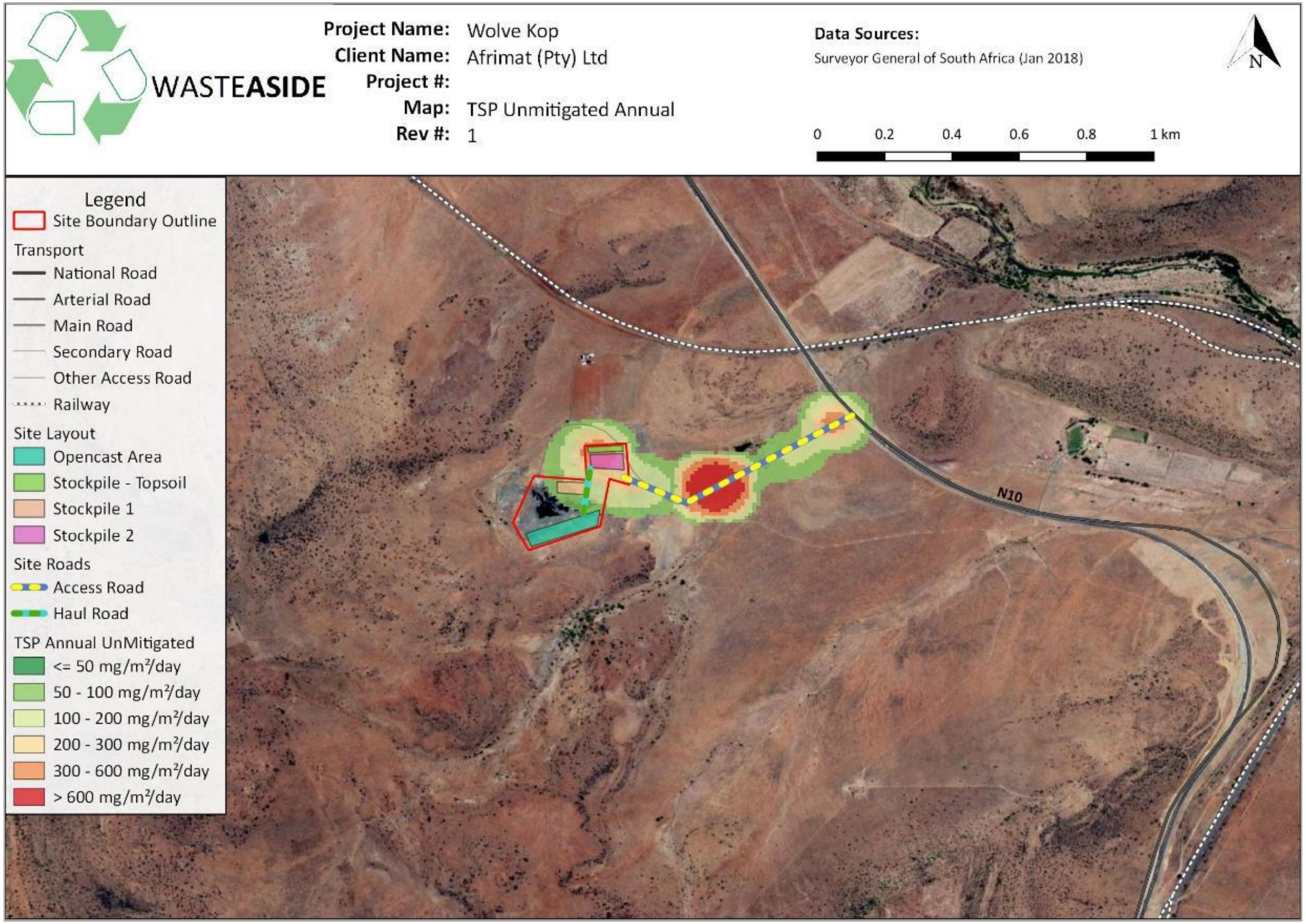


Figure 17: Predicted average annual concentrations for TSP for the Afrimat Wolve Kop project when unmitigated.

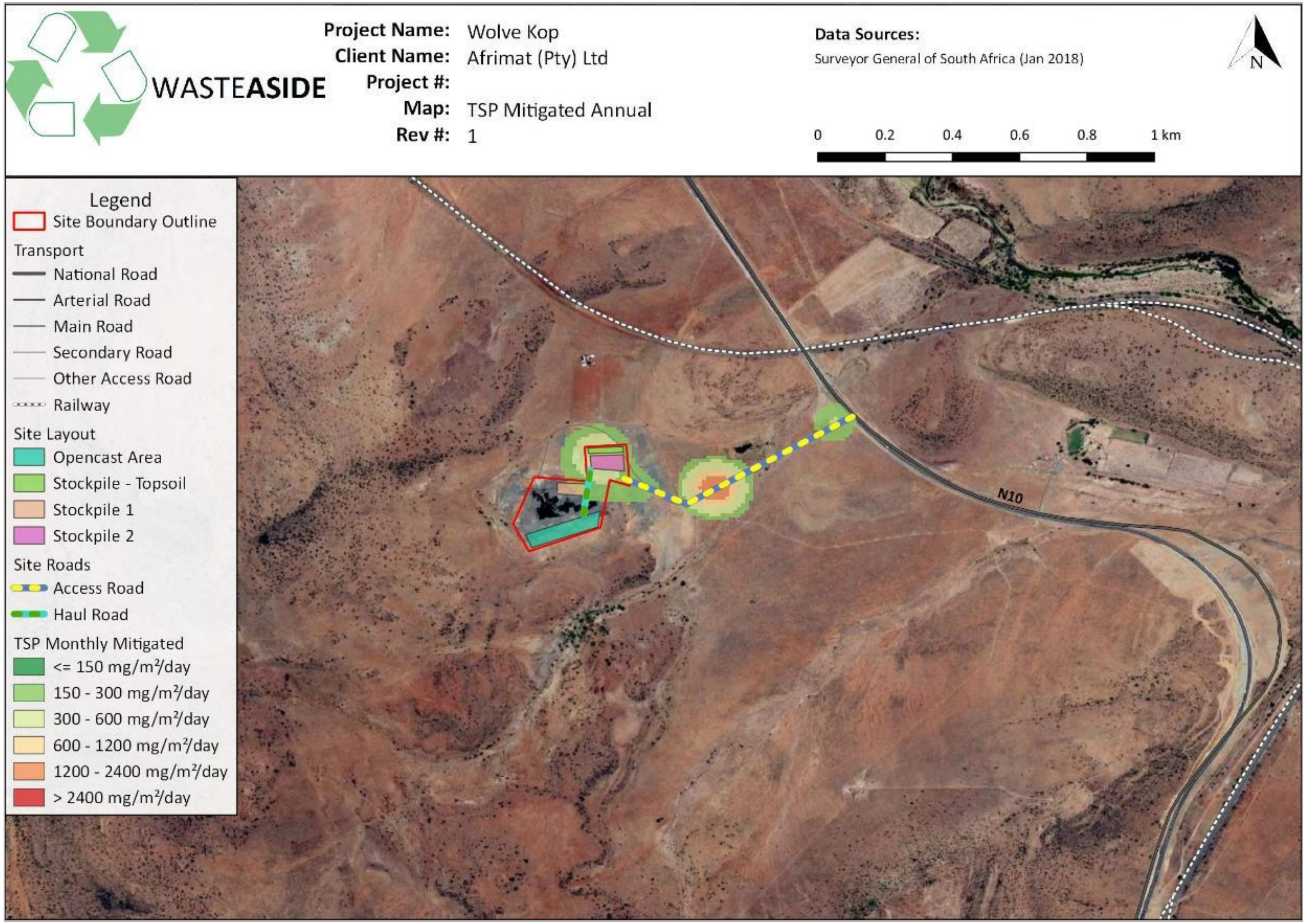


Figure 18: Predicted average annual concentrations for TSP for Afrimat Wolve Kop project operations when mitigated

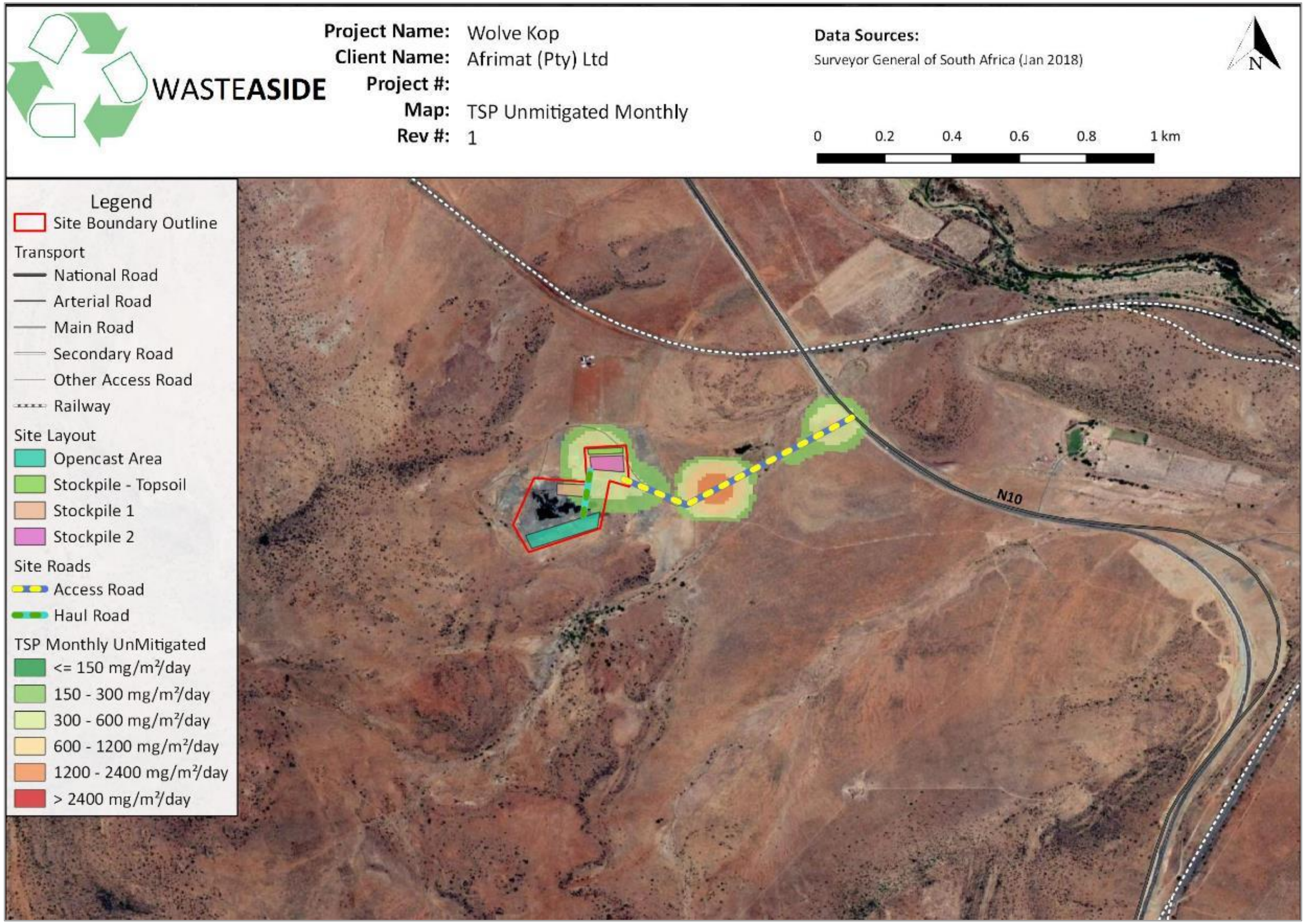


Figure 19: Predicted Highest Monthly concentrations for TSP for Afrimat Wolve Kop project operations when unmitigated.

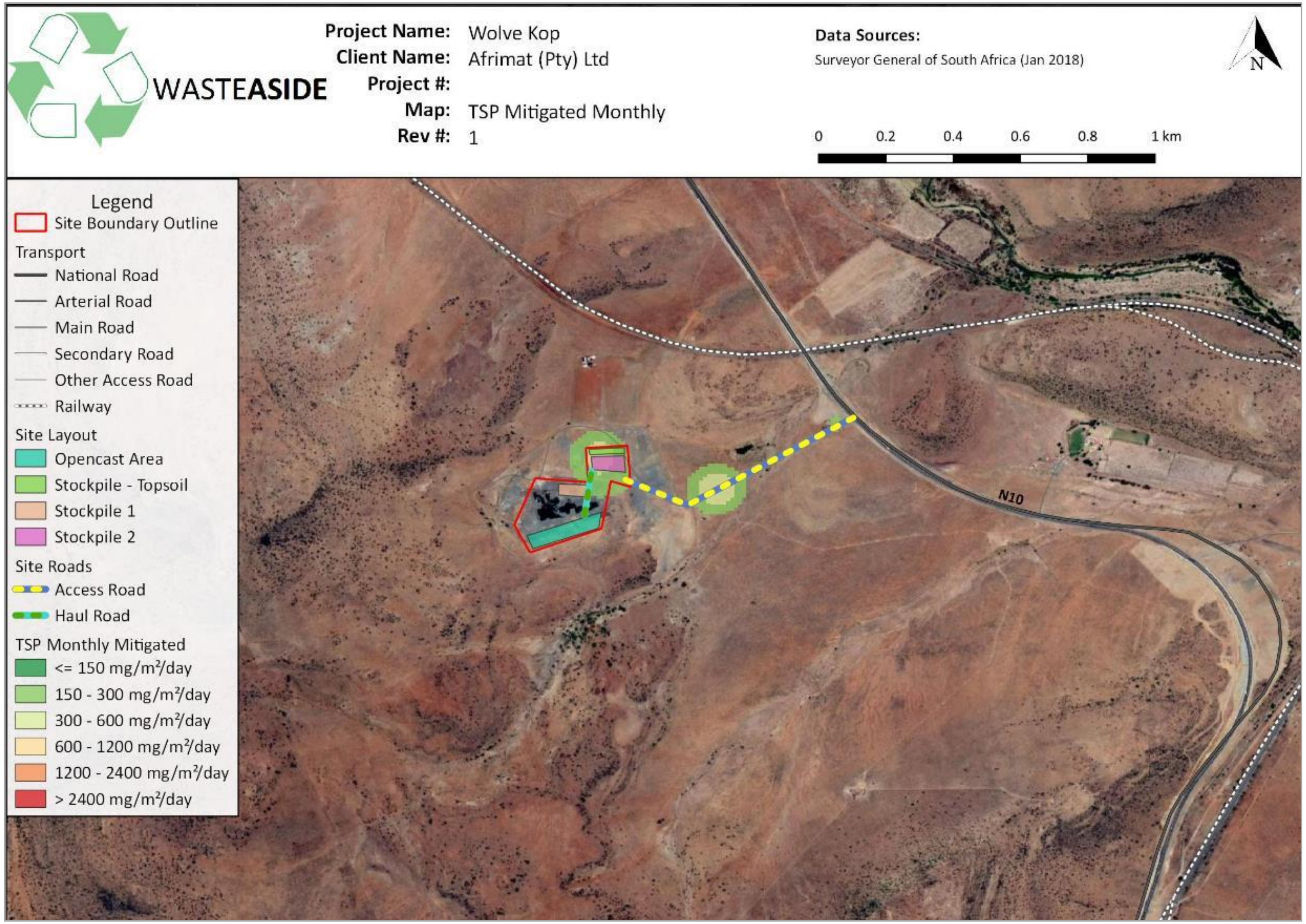


Figure 20: Predicted Highest Monthly concentrations for TSP for Afrimat Wolve Kop project operations when mitigated

8. IMPACT ASSESMENT

Impact Assessment Methodology

The level of detail as depicted in the EIA regulations were fine-tuned by assigning specific values to each impact. In order to establish a coherent framework within which all impacts could be objectively assessed, it was necessary to establish a rating system, which was applied consistently to all the criteria. For such purposes each aspect was assigned a value, ranging from one (1) to five (5), depending on its definition. This assessment is a relative evaluation within the context of all the activities and the other impacts within the framework of the project.

The impact assessment criteria used to determine the impact of the proposed development are as follows:

1. ***Severity*** of the impact;

1. **Spatial Scale** - The physical and spatial scale of the impact;

2. ***Duration*** - The lifetime of the impact, measured in relation to the lifetime of the proposed development;

3. ***Frequency of the Activity*** – How often do the activity take place;

4. ***Frequency of the incident/impact*** – How often does the activity impact on the environment;

5. ***Legal Issues*** – How is the activity governed by legislation;

6. ***Detection*** – How quickly/easily the impacts/risks of the activity be detected on the environment, people and property;

To ensure uniformity, the assessment of potential impacts will be addressed in a standard manner so that a wide range of impacts is comparable. For this reason, a clearly defined rating scale will be provided to the specialist to assess the impacts associated with their investigation.

Table 9: Assessment criteria

SEVERITY	
Insignificant / non-harmful	1
Small / potentially harmful	2
Significant / slightly harmful	3
Great / harmful	4
Disastrous / extremely harmful / within a regulated sensitive area	5
SPATIAL SCALE	
Area specific (at impact site)	1
Whole site (entire surface right)	2
Local (within 5 km)	3
Regional / neighboring areas (5 km to 50 km)	4
National	5
DURATION	
One day to one month (immediate)	1
One month to one year (Short term)	2
One year to 10 years (medium term)	3
Life of the activity (long term)	4
Beyond life of the activity (permanent)	5
FREQUENCY OF THE ACTIVITY	
Annually or less	1
6 monthly	2
Monthly	3
Weekly	4
Daily	5
FREQUENCY OF THE INCIDENT/IMPACT	
Almost never / almost impossible / >20%	1
Very seldom / highly unlikely / >40%	2
Infrequent / unlikely / seldom / >60%	3
Often / regularly / likely / possible / >80%	4
Daily / highly likely / definitely / >100%	5
LEGAL ISSUES	
No legislation	1

Fully covered by legislation	5
DETECTION	
Immediately	1
Without much effort	2
Need some effort	3
Remote and difficult to observe	4
Covered	5
Immediately	1

The impacts that are generated by the development can be minimized if measures are implemented in order to reduce the impacts. The mitigation measures ensure that the development considers the environment and the predicted impacts in order to minimize impacts and achieve sustainable development.

Consequence

Consequence is determined by the following equation after the assessment of each impact.

Consequence = Severity + Spatial Scale + Duration

Likelihood

The Likelihood of the activity is then calculated based on frequency of the activity and impact, how easily it can be detected and whether the activity is governed by legislation. Thus:

Likelihood = Frequency of activity + frequency of impact + legal issues + detection

Risk

The risk is then based on the consequence and likelihood.

Risk = Consequence x likelihood

Impact Ratings

The impact is then rated according to the following table:

Table 10: Impact Rating Table

Rating	Class
1-55	(L) Low Risk
56-169	(M) Moderate Risk
170-600	(H) High Risk

9. DISPERSION MODEL

Summarized Impacts According to Development Phases

Table 11: Impacts according to Development Phases

PHASE	ACTIVITIES
Operational Phase	As per Modelling
Closure and Decommissioning	**Activity 1** - Demolition & Removal of all infrastructure (incl. transportation off site); and
	Activity 2- Rehabilitation (spreading of soil, revegetation & profiling/contouring).

Operational Phases

1. Un-mitigated;
2. Mitigated – Sources as Specified;

PM_{10}

For the unmitigated and mitigated Daily PM_{10} concentrations it was predicted not to be higher than the 75 µg/m³ limit for any of the sensitive receptors.

The annual average PM_{10} limit of 40 µg/m³ are not predicted to exceed at any of the identified sensitive receptors for any of the modelled scenarios.

Table 12: PM Concentrations at sensitive receptors

Receptor	PM_{10} 2nd Highest Daily (µg/m³)		PM_{10} Annual Average (µg/m³)	
	Unmitigated	Mitigated	Unmitigated	Mitigated
1	1.19	0.50	0.03	0.01
2	4.64	1.57	0.16	0.05
3	1.32	0.48	0.02	0.01
4	0.72	0.27	0.04	0.01
5	0.67	0.26	0.03	0.01
6	2.43	1.06	0.02	0.01

Total Dust Fallout

In the mitigated and unmitigated scenarios none of the sensitive receptors are predicted to exceed the monthly dust fallout for the highest month residential limit of 600 mg/m²/day.

The predicted annual dust fall out for the mitigated and unmitigated scenarios are not predicted to exceed the annual limit of 300 mg/m²/day at any of the sensitive receptors.

Table 13: TSP Deposition rates at the sensitive receptors

Receptor	TSP Highest Monthly (mg/m²/day)		TSP Annual Average (mg/m²/day)	
	Unmitigated	Mitigated	Unmitigated	Mitigated
1	1.45	0.70	0.17	0.07
2	2.38	0.88	1.13	0.39
3	0.79	0.36	0.20	0.08
4	0.46	0.21	0.28	0.11
5	0.45	0.21	0.28	0.11
6	0.15	0.07	0.04	0.02

Decommissioning and Closure Phase

It is assumed that the decommissioning activities will only take place during daylight hours. The following activities during the Decommissioning and Closure phase are identified as possible air impacting sources and may impact on the ambient air quality at the relevant sensitive receivers:

Activity 1 - Demolition & Removal of all infrastructure (incl. transportation off site).

Activity 2 - Rehabilitation (spreading of soil, revegetation & profiling/contouring).

The decommissioning phase is associated with activities related to the demolition of infrastructure and the rehabilitation of disturbed areas. The following activities are associated with the decommissioning phase (US-EPA, 1996):

- Existing buildings and structures demolished, rubble removed and the area levelled;
- Remaining exposed excavated areas filled and levelled using overburden recovered from stockpiles;

- Stockpiles to be smoothed and contoured;
- Topsoil replaced using topsoil recovered from stockpiles; and
- Disturbed land prepared for revegetation.
- Possible sources of fugitive dust emission during the closure and post-closure phase include:
- Smoothing of stockpiles by bulldozer;
- Grading of sites;
- Transport and dumping of overburden for filling;
- Infrastructure demolition;
- Infrastructure rubble piles;
- Transport and dumping of building rubble;
- Transport and dumping of topsoil; and
- Preparation of soil for revegetation – ploughing and addition of fertilizer, compost etc.

Exposed soil is often prone to erosion by water. The erodibility of soil depends on the amount of rainfall and its intensity, soil type and structure, slope of the terrain and the amount of vegetation cover (Brady, 1974). Revegetation of exposed areas for long-term dust and water erosion control is commonly used and is the most cost-effective option. Plant roots bind the soil, and vegetation cover breaks the impact of falling raindrops, thus preventing wind and water erosion. Plants used for revegetation should be indigenous to the area, hardy, fast-growing, nitrogen-fixing, provide high plant cover, be adapted to growing on exposed and disturbed soil (pioneer plants) and should easily be propagated by seed or cuttings.

Table 14: Activity 1: Demolition & Removal of all infrastructure (incl. transportation off site)

Mining Phase	Closure and Decommissioning Phase		
Impact description	During this activity, there is demolition of buildings and foundation and subsequent removal of rubbles generated. There is cleaning-up of workshops, fuels and reagents, removal of power and water supply, removal of haul and access roads. Potential for impacts during this phase will depend on the extent of demolition and rehabilitation efforts during closure as well as features which will remain. The impacts on the atmospheric environment during the decommissioning phase will be similar to the impacts during the construction phase. The process includes dismantling and demolition of existing infrastructure, transporting and handling of topsoil on unpaved roads in order to bring the site to its initial/rehabilitated state. Demolition and removal of all infrastructures will cause fugitive dust emissions. The impacts will be short-term and localized. Any implication or implications this phase will have on ambient air quality will seize once the activities are finalized.		
		Unmitigated	**Mitigated**
Assessment Criteria	**Severity** [Insignificant / non-harmful (1); Small / potentially harmful (2); Significant / slightly harmful (3); Great / harmful (4); Disastrous / extremely harmful / within a regulated sensitive area (5)]	3	3
	Spatial Scale [Area specific (at impact site) (1); Whole site (entire surface right) (2); Local (within 5km) (3); Regional / neighbouring areas (5km to 50km) (4); National (5)]	2	2
	Duration [One day to one month (immediate) (1); One month to one year (Short term) (2); One year to 10 years (medium term) (3); Life of the activity (long term) (4); Beyond life of the activity (permanent) (5)]	2	2
	Frequency of Activity [Annually or less (1); 6 monthly (2); Monthly (3); Weekly (4); Daily (5)]	4	4

Mining Phase	Closure and Decommissioning Phase		
	Frequency of Incident/Impact [Almost never / almost impossible / >20% (1); Very seldom / highly unlikely / >40% (2); Infrequent / unlikely / seldom / >60% (3); Often / regularly / likely / possible / >80% (4); Daily / highly likely / definitely / >100% (5)	4	3
	Legal Issues [No legislation (1); Fully covered by legislation (5)]	5	5
	Detection [Immediately (1); Without much effort (2); Need some effort (3); Remote and difficult to observe (4); Covered (5)]	2	2
Consequence	Severity + Spatial Scale + Duration	7	7
Likelihood	Frequency of Activity + Frequency of impact + Legal issues + Detection	15	14
Risk	Consequence * Likelihood	MODERATE (105)	MODERATE (98)
Mitigation Measures	• Demolition should not be performed during windy periods (August, September and October), as dust levels and the area affected by dust fallout will increase. • The area of disturbance must be kept to a minimum, as demolition should be done judiciously avoid the exposure of larger areas to wind erosion. • Cabs of machines should be swept or vacuumed regularly to remove accumulated dust. • Exhaust pipes of vehicles should be directed so that they do not raise dust. • Engine cooling fans of vehicles should be shrouded so that they do not raise dust. • Hard surfaced haul roads or standing areas should be washed down and swept to remove accumulated dust. • Dust suppression of roads being used during rehabilitation should be enforced.		

Table 15: Activity 2: Rehabilitation (spreading of soil, revegetation & profiling/contouring)

Mining Phase	Closure and Decommissioning Phase		
Impact description	During this activity, there is the reshaping and restructuring of the landscape. Since this is an opencast operation mainly, the area to be reconstructed will be limited to the opencast areas. Topsoil can be imported to reconstruct the soil structure. There is less transfer of soil from one area to other therefore negligible chances of dust through wind erosion. Profiling of dumps to enhance vegetation cover and reduce wind erosion from such surfaces post mining.		
		Unmitigated	**Mitigated**
Assessment Criteria	**Severity** [Insignificant / non-harmful (1); Small / potentially harmful (2); Significant / slightly harmful (3); Great / harmful (4); Disastrous / extremely harmful / within a regulated sensitive area (5)]	4	3
	Spatial Scale [Area specific (at impact site) (1); Whole site (entire surface right) (2); Local (within 5km) (3); Regional / neighbouring areas (5km to 50 km) (4); National (5)]	2	2
	Duration [One day to one month (immediate) (1); One month to one year (Short term) (2); One year to 10 years (medium term) (3); Life of the activity (long term) (4); Beyond life of the activity (permanent) (5)]	2	2
	Frequency of Activity [Annually or less (1); 6 monthly (2); Monthly (3); Weekly (4); Daily (5)]	5	5
	Frequency of Incident/Impact [Almost never / almost impossible / >20% (1); Very seldom / highly unlikely / >40% (2); Infrequent / unlikely / seldom / >60% (3); Often / regularly / likely / possible / >80% (4); Daily / highly likely / definitely / >100% (5)	5	4
	Legal Issues [No legislation (1); Fully covered by legislation (5)]	5	5
	Detection [Immediately (1); Without much effort (2); Need some effort (3); Remote and difficult to observe (4); Covered (5)]	2	2
Consequence	Severity + Spatial Scale + Duration	8	7
Likelihood	Frequency of Activity + Frequency of impact + Legal issues + Detection	17	16
Risk	Consequence * Likelihood	MODERATE (136)	MODERATE (112)

Mining Phase	Closure and Decommissioning Phase
Mitigation Measures	• Revegetation of exposed areas for long-term dust and water erosion control is commonly used and is the most cost-effective option. • Plants with roots that bind the soil, and vegetation cover should be used that breaks the impact of falling raindrops, thus preventing wind and water erosion. • Plants used for revegetation should be indigenous to the area, hardy, fast-growing, nitrogen-fixing, provide high plant cover, be adapted to growing on exposed and disturbed soil (pioneer plants) and should easily be propagated by seed or cuttings. • The area of disturbance must be kept to a minimum, as demolition should be done judiciously avoid the exposure of larger areas to wind erosion. • Spreading of soil must be performed on less windy days. • The bare soil will be prone to erosion and therefore there is need to reduce the velocity near the surface of the soil by re-vegetation. • Leaving the surface of soil in a coarse condition reduces wind erosion and ultimately reduces dust levels. • Additional mitigation measures include keeping soil moist using sprays or water tanks, using wind breaks. • The best time to re-vegetate the area must be linked to the distribution and reliability of rainfall. • Cabs of machines should be swept or vacuumed regularly to remove accumulated dust. • Exhaust pipes of vehicles should be directed so that they do not raise dust. • Engine cooling fans of vehicles should be shrouded so that they do not raise dust. • Hard surfaced haul roads or standing areas to be washed down and swept to remove accumulated dust. • Dust suppression of roads being used during rehabilitation should be enforced. • It is recommended that the rehabilitation by vegetating should begin during the operational phase already as the objective is to minimize the erosion. • These measures should be aimed to reduce the potential for fugitive dust generation and render the impacts on ambient air quality negligible.

10. MONITORING PROGRAMME

At the time of this report no passive sampling campaign do exist for the Afrimat Wolve Kop project. It is highly recommended a monitoring campaign is established that include all 8 main compass directions.

Gravimetrical Dust Fallout – (Milligram/Square Meter/Day) Or (Mg/M²/Day) (Monthly 8 Samples)

Proposed Monitor Locations

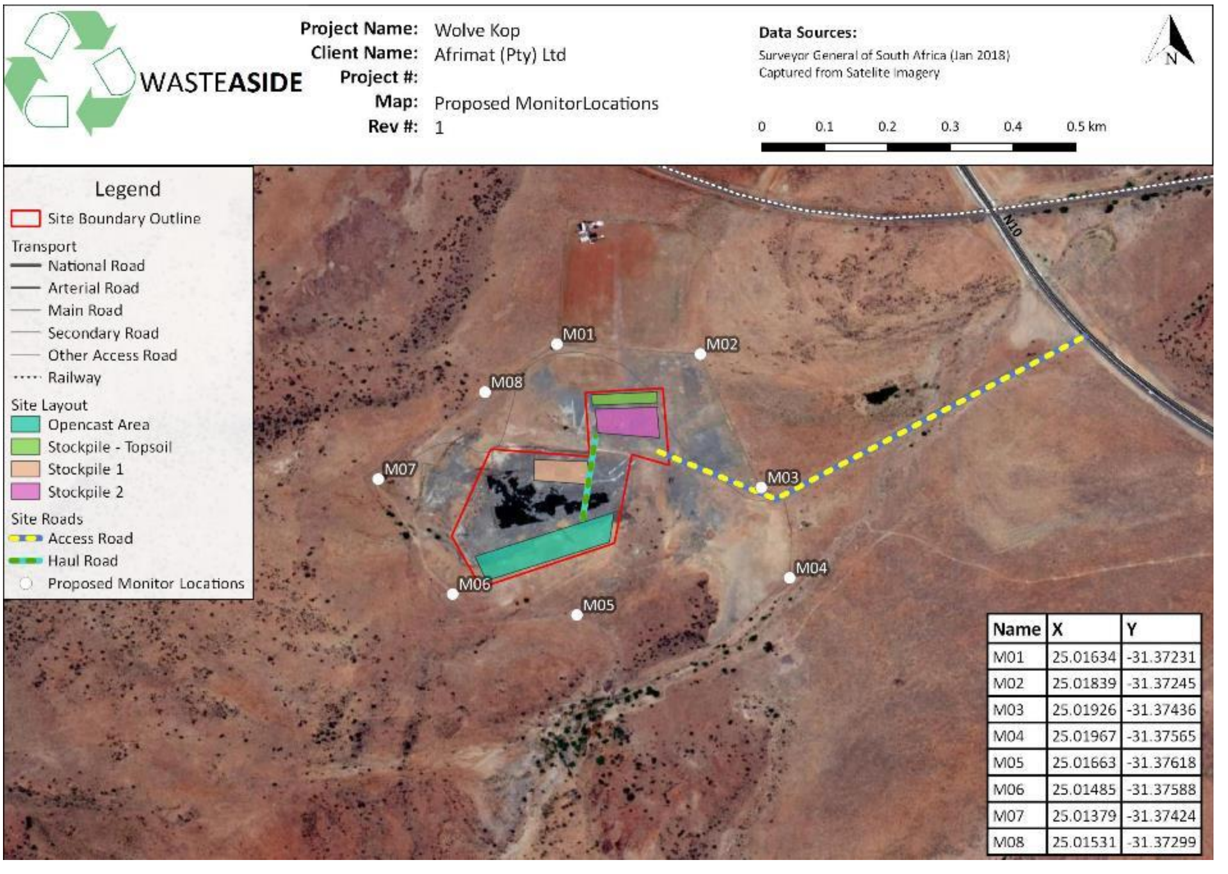


Figure 21 Proposed Monitor Locations

Site layout for sampling points must be carried out according to the eight main compass directions; the site layout and equipment placement must be done in accordance with the ASTM standard, D 1739 – 2010, thereafter relevant sampling reference numbers will be allocated to the receptors accordingly. At each gravimetric dust fallout gauge/receptor point there is a stand built according to specification containing the dust sample collection bucket. Samples will be collected after a 1 month running period (+-30 day's exposure). After sample collection, the samples are taken to a SANAS accredited laboratory as required. A visual site investigation is done where after correlations are drawn and findings are identified and reported on.

Dust buckets of a standard size and shape are prepared and set up at locations related to the eight main compass points on the borders of the property so that dust can settle in them for periods of 30+/-2 days. The dust buckets are then sealed and replaced with new empty ones and send away to the SANAS accredited laboratory for analysis. The masses of the water-soluble and –insoluble components of the material collected are then determined and results are reported as mg/m²/day. This methodology is described according to South African National Standards 1929:2004 and the American Society for Testing and Materials (ASTM) Designation: D 1739-98 (2010). The results for this method of testing are obtained by gravimetrical weighing. The apparatus required include open top buckets/containers not less than 150 mm in diameter with a height not less than twice its diameter. The buckets must be placed on a stand at a height of 2 +/-0.2 m above the ground.

11. CONCLUSION

The air quality impact assessment undertaken for the project includes a meteorological overview of the area. An emissions inventory was undertaken with the aim of quantifying emissions associated with the activities involved in the mining of coal. The emissions for specific activities such as bulldozing, blasting, tipping, wind erosion and materials handling activities were calculated and the cumulative impacts were compared to the relevant ambient air quality standards to determine legal compliance.

The findings reported here is therefore a combination of historical, observed and previously modelled data and provided the background and predicted scenario of various pollutants in the Afrimat Wolve Kop project mining area. The construction and operational phases were assessed. Based on the dispersion modelling simulations, the following conclusions can be summarized as follows:

PM_{10}

For the unmitigated and mitigated Daily PM_{10} concentrations it was predicted not to be higher than the 75 µg/m³ limit for any of the sensitive receptors.

The annual average PM_{10} limit of 40 µg/m³ are not predicted to exceed at any of the identified sensitive receptors for any of the modelled scenarios.

TSP

In the mitigated and unmitigated scenarios none of the sensitive receptors are predicted to exceed the monthly dust fallout for the highest month residential limit of 600 mg/m²/day.

The predicted annual dust fall out for the mitigated and unmitigated scenarios are not predicted to exceed the annual limit of 300 mg/m²/day at any of the sensitive receptors.

Recommendations

Based on the results presented the following further recommendations are outlined:

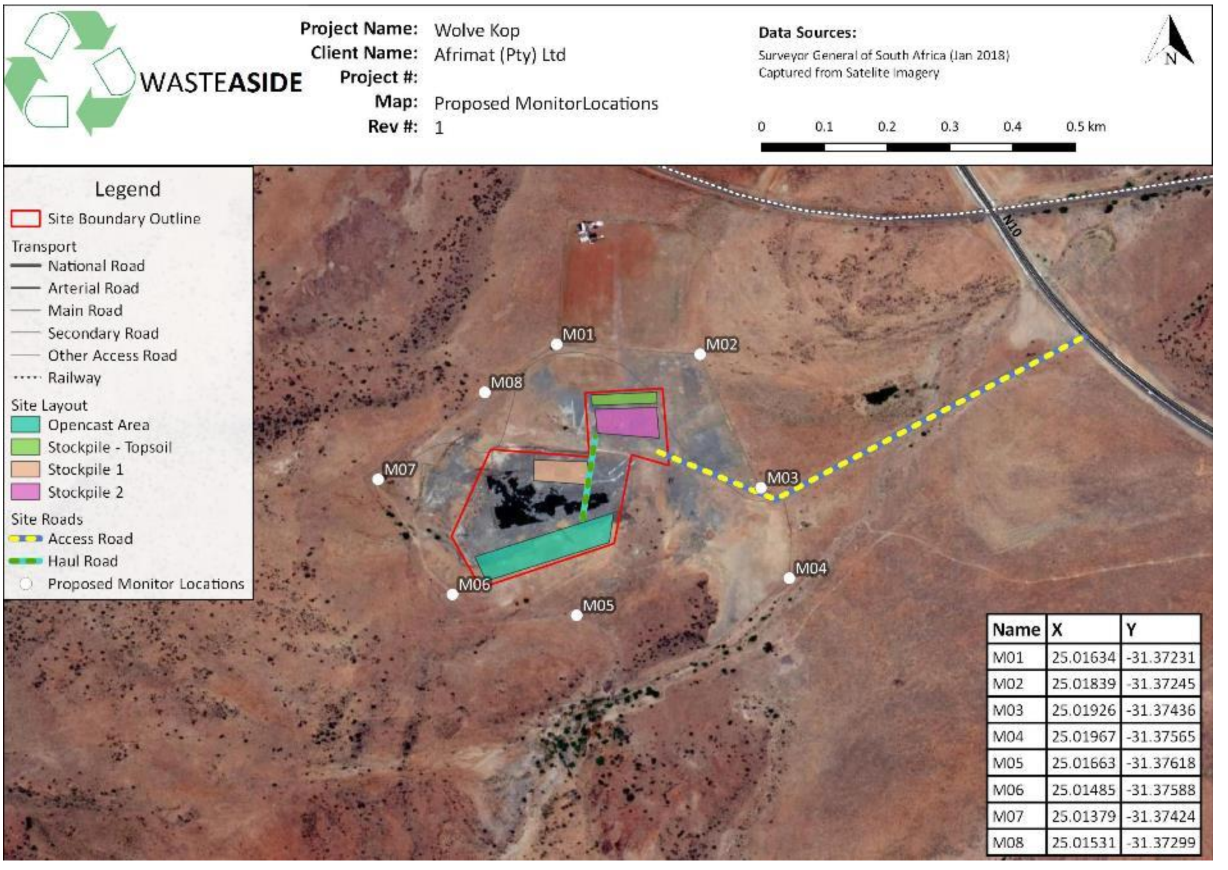
- Fallout monitoring should be established to include all 8 compass directions.
- Fallout monitoring is to be continued for the life of mine to better assess the level of nuisance dust associated with both mining and process related operations. Sampling of fallout should be undertaken within the neighbouring areas as well as on-site. Dust fallout monitoring is recommended at the locations as shown in Figure 22.
- PM_{10} and $PM_{2.5}$ dust monitoring must also be undertaken at the same sites as mentioned under the previous bullet but also in and around potential fugitive emission sources to determine mitigation measures and focus management efforts.

Further mitigation measures that should be applied, if it is found that dust and PM_{10} levels are measured to be exceeding the limits are:

- Fully sealed Pit and Access Haul Roads to achieve 90-100% mitigation on these roads.

The impacts from dust fallout and Particulate matter can be reduced by implementing dust control measures. The highest intensity of the construction work should be carried out during the summer months and not over the harsh winter months as can result in increased dispersion of fugitive dust. The mine should ensure that unpaved roads are continuously watered and treated with dust binding additive products to reduce the volume of fugitive dust emitted from unpaved roads.

The mitigation and management measures for mining operation and discussed in this report should be sufficient to ensure the mining operation can be conducted with minimal impact on the receiving environment and therefore not have a detrimental effect and can go ahead.



Name	X	Y
M01	25.01634	-31.37231
M02	25.01839	-31.37245
M03	25.01926	-31.37436
M04	25.01967	-31.37565
M05	25.01663	-31.37618
M06	25.01485	-31.37588
M07	25.01379	-31.37424
M08	25.01531	-31.37299

Figure 22 Proposed Monitor Locations

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