Air Quality Specialist Scoping Report for the Proposed New Ash Disposal Facility at Arnot Power Station

Project done on behalf of **Environmental Impact Management Services (Pty) Ltd**

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Revision Record

Revision Number	**Date**	**Reason for Revision**
Draft Scoping	January 2017	For client review
0.1	January 2017	Incorporation of comments provided by EIMS
1.0	May 2018	Scoping report for two new alternative ash disposal facility sites

EXECUTIVE SUMMARY

A new ash disposal facility is proposed for the Arnot Power Station (hereafter referred to as the proposed project). Airshed Planning Professionals (Pty) Ltd was appointed by Environmental Impact Management Services (Pty) Ltd to undertake a Scoping Level Investigation including a Baseline Assessment for the proposed project.

The aim of this investigation was to determine baseline air quality conditions, delineate potential sensitive receptors and identify potential impacts to air quality that may arise from the proposed project; all of which will form the basis for the air quality impact assessment to be conducted.

Determination of the baseline air quality characterisation included:

- The assessment of site-specific atmospheric dispersion potential;
- The identification of existing sources of emissions in the area;
- The identification of the potential sensitive receptors within the vicinity of the proposed project site;
- The characterisation of ambient air quality in the region based on observational data recorded to date (if available);
- The legislative and regulatory context, including national ambient air quality standards; and,
- Identification of the potential impacts from proposed operations on air quality that could affect environmental and/or human health.

The main findings from the scoping level assessment were as follows:

- The flow field is dominated by winds from the east and northwestern sectors. During day-time conditions, winds from the northwest are more frequent, with winds from the easterly sector increasing at night.
- The closest residential area to the proposed project is Rietkuil, north of the existing Arnot Power Station ash facility. Individual farmsteads also surround the project area.
- Criteria pollutants emitted during the proposed project operations will include particulate matter.

EIA Regulations require that impacts be assessed in the scoping phase in terms of the nature, significance, consequence, extent, duration and probability of the impacts including the degree to which these impacts can be reversed, may cause irreplaceable loss of resources, and can be avoided, managed or mitigated.

Two alternatives were considered. The significance ranking of Alternative 1 and Alternative 2 would be similar as the impacts offsite would be comparable in magnitude and spatial distribution. The impacts for all three alternatives were therefore assessed together and had a low significance ranking for construction and decommissioning phases and a medium significance ranking for operational phase.

Due to the location of sensitive receptors to the proposed project sites, both alternatives are likely to impact on the same number of receptors so there is no clear preferable site.

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LIST OF ACRONYMS AND SYMBOLS

APCS	Air Pollution Control System
AQA	Air Quality Act
CEPA	Canadian Environmental Protection Agency
CO	Carbon monoxide
CO_2	Carbon dioxide
DEA	Department of Environmental Affairs (previously known as the Department of Environmental Affairs and Tourism-DEAT)
EIA	Environmental Impact Assessment
g	gram
HPA	Highveld Priority Area
m	Meter
m^2	Meter squared
m^3	Meter cubed
NAAQS	National Ambient Air Quality Standards
NDCR	National Dust Control Regulations
NOAEL	No adverse effect levels
NO_x	Oxides of nitrogen
NO_2	Nitrogen dioxide
O_3	Ozone
Pb	Lead
PM	Particulate matter
PM_{10}	Particulate matter with an aerodynamic diameter of less than 10μm
$PM_{2.5}$	Particulate matter with an aerodynamic diameter of less than 2.5μm
SAAQIS	South African Air Quality Information System
SA	South African
SANS	South African National Standard
SO_2	Sulfur dioxide
TSP	Total suspended particulates
US EPA	United States Environmental Protection Agency
WHO	World Health Organisation
µ	micro

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1 INTRODUCTION

A new ash disposal facility is proposed for the Arnot Power Station (hereafter referred to as the proposed project). Airshed Planning Professionals (Pty) Ltd was appointed by Environmental Impact Management Services (Pty) Ltd to undertake a Scoping Level Investigation including a Baseline Assessment for the proposed project.

The aim of this investigation was to determine baseline air quality conditions, delineate potential sensitive receptors and identify potential impacts to air quality that may arise from the proposed project; all of which will form the basis for the air quality impact assessment to be conducted.

1.1 Project Description

Arnot Power Station require a new ash disposal facility for their operations. A site selection process was undertaken and four 80 ha sites (i.e. Alternative 1, Alternative 2, Alternative 3 and Alternative 4) and three 120 ha sites (i.e. Alternative 1, Alternative 2 and Alternative 3) selected for the proposed facility (Figure 1-1 and Figure 1-2). From this process, two 120 ha sites were selected for the scoping phase (Figure 1-3). The proposed project will make use of wet ashing technology.

1.2 Terms of Reference

The scoping level air quality characterisation includes:

- The assessment of site-specific atmospheric dispersion potential;
- The identification of existing sources of emissions in the area;
- The identification of the potential sensitive receptors within the vicinity of the proposed project site;
- The characterisation of ambient air quality in the region based on observational data recorded to date (if available);
- The review of legislative and regulatory context, including national ambient air quality standards; and,
- Identification of the potential impacts from proposed operations on air quality that could affect environmental and/or human health.

1.3 Outline of Report

The regulatory requirements are discussed in Section 2. A description of the receiving environment is provided in Section 3 followed by a description of the potential impacts from the proposed project in Section 4. The significance rating is given in Section 5. Section 6 comprises a plan of study for the impact assessment with assumptions provided in Section 7.

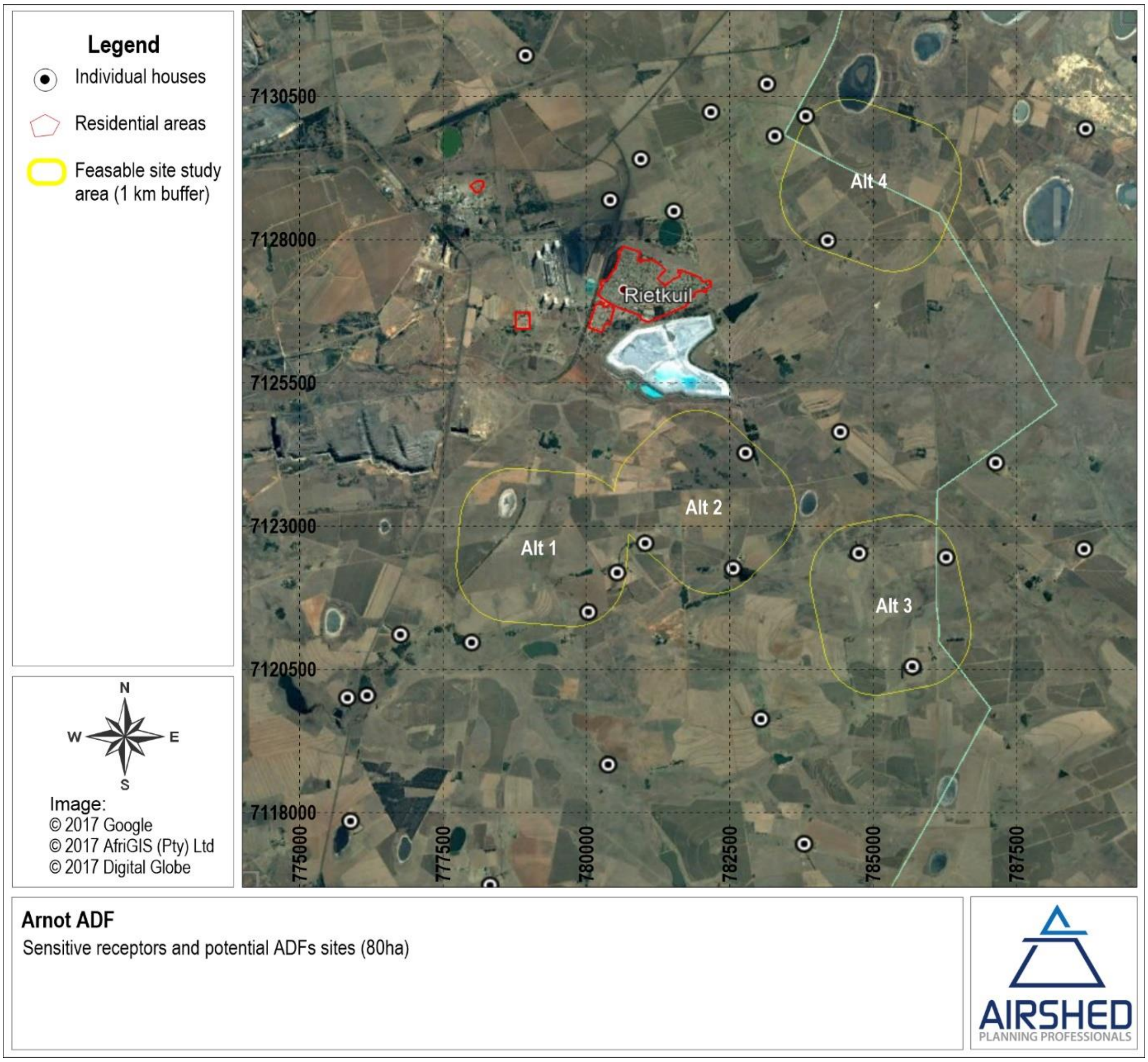
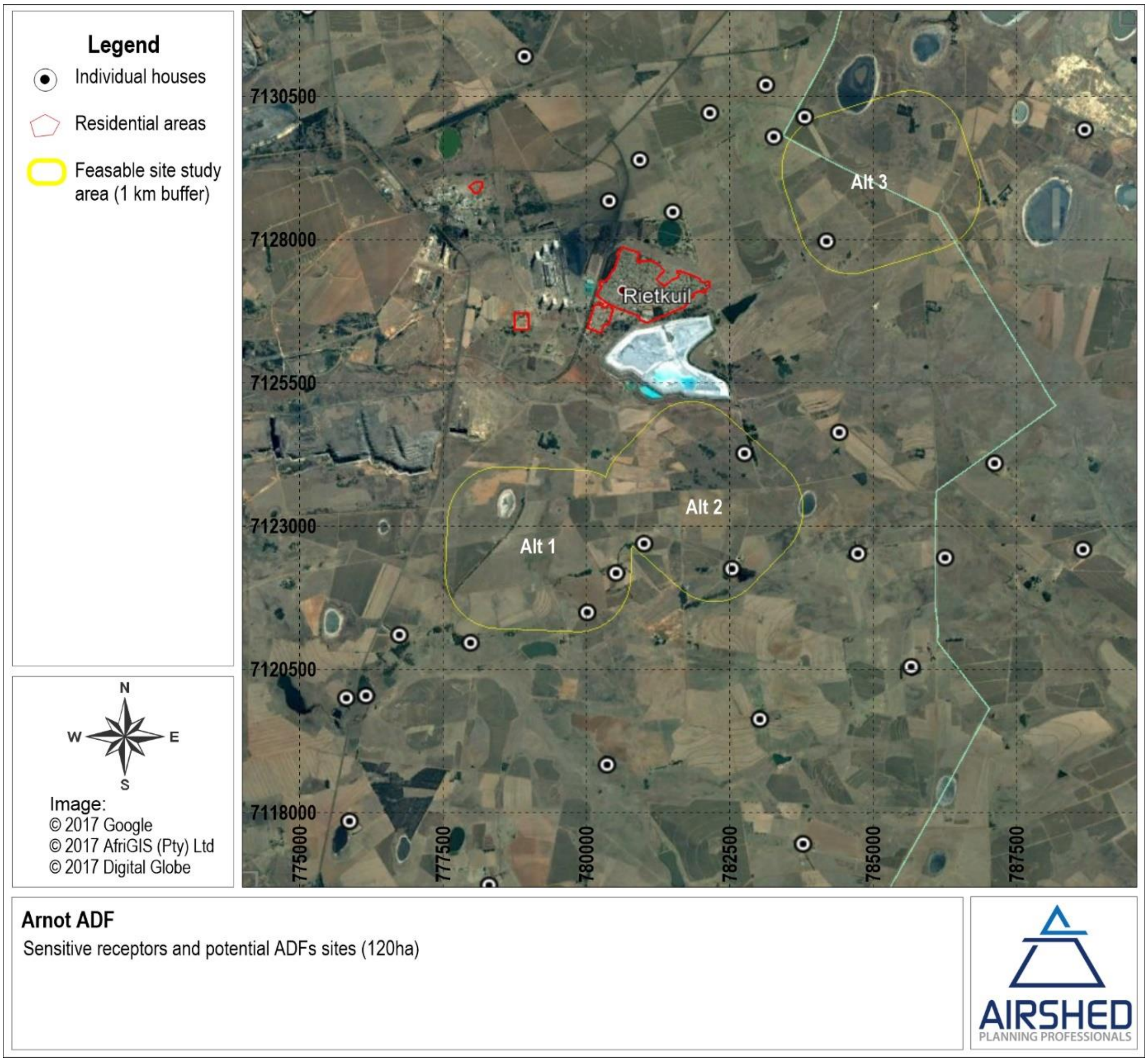


Figure 1-1: Location of sensitive receptors and potential 80ha ash disposal facility sites (1 km buffer) assessed for the site selection process



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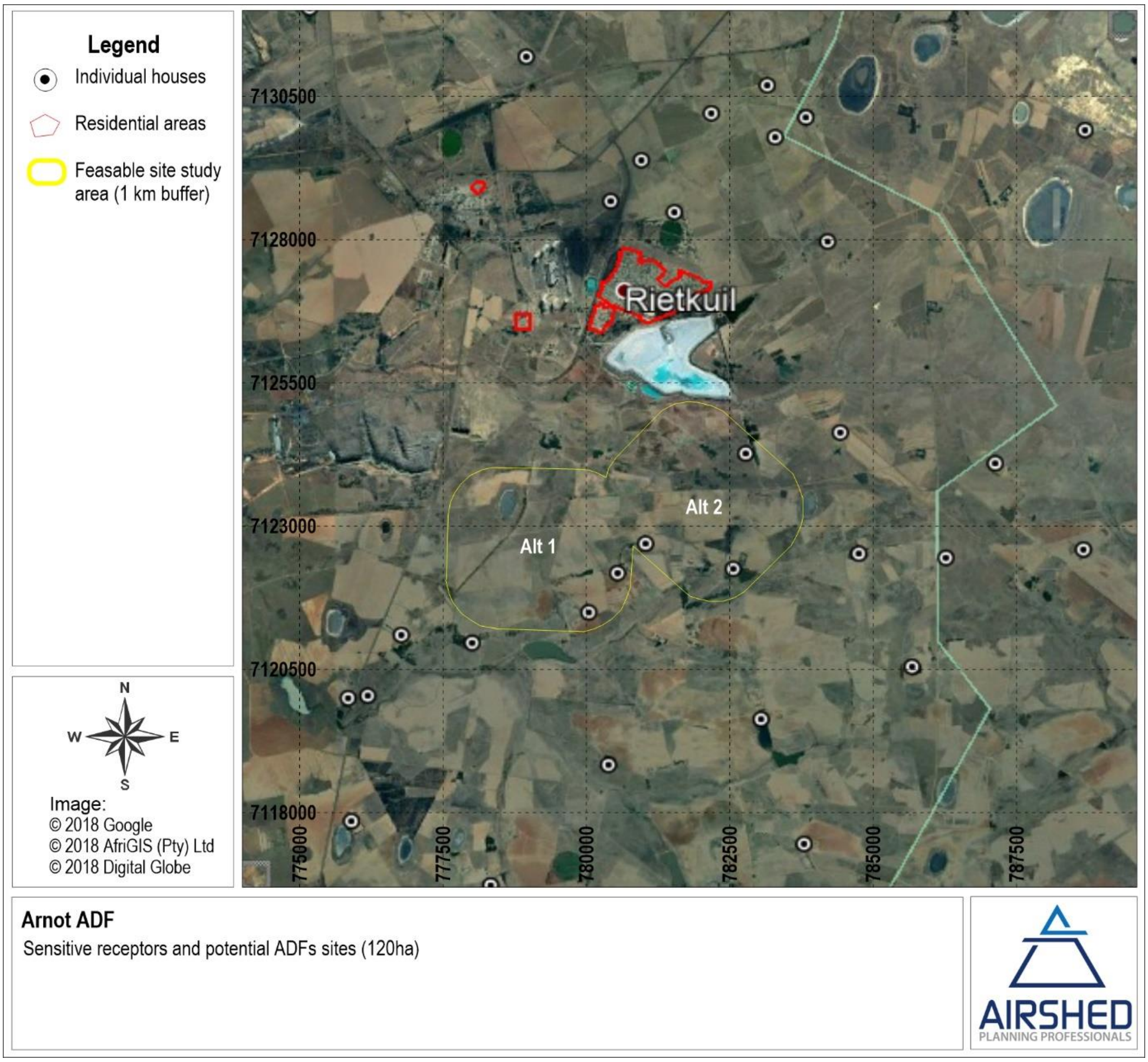


Figure 1-3: Location of sensitive receptors and potential 120ha ash disposal facility sites (1 km buffer) assessed for the scoping phase

2 REGULATORY REQUIREMENTS AND ASSESSMENT CRITERIA

The environmental regulations and guidelines governing the emissions and impact of the proposed project need to be considered prior to potential impacts and sensitive receptors being identified.

Air quality guidelines and standards are fundamental to effective air quality management, providing the link between the source of atmospheric emissions and the user of that air at the downstream receptor site. The ambient air quality standards are intended to indicate safe daily exposure levels for the majority of the population, including the very young and the elderly, throughout an individual's lifetime. Air quality guidelines and standards are normally given for specific averaging periods. These averaging periods refer to the time-span over which the air concentration of the pollutant was monitored at a location. Generally, five averaging periods are applicable, namely an instantaneous peak, 1-hour average, 24-hour average, 1-month average, and annual average.

2.1 National Ambient Air Quality Standards

National Ambient Air Quality Standards (NAAQS) are available for inhalable particulate matter less than 2.5 µm in diameter ($PM_{2.5}$) gazetted on 29 June 2012 (no. 35463), inhalable particulate matter less than 10 µm in diameter (PM_{10}), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3), carbon monoxide (CO), lead (Pb) and benzene gazetted on 24 December 2009. The NAAQS are provided in Table 2-1 with the pollutants of concern for the proposed project provided in bold text.

Table 2-1: South African National Ambient Air Quality Standards

Substance	Molecular formula / notation	Averaging period	Concentration limit (µg/m^3)	Frequency of exceedance	Compliance date
Sulfur dioxide	SO_2	10 minutes	500	526	Currently enforced
		1 hour	350	88	Currently enforced
		24 hours	125	4	Currently enforced
		1 year	50	-	Currently enforced
Nitrogen dioxide	NO_2	1 hour	200	88	Currently enforced
		1 year	40	-	Currently enforced
Particulate matter	**PM_{10}**	**24 hour**	**75**	**4**	**Currently enforced**
		1 year	**40**	**-**	**Currently enforced**
Fine particulate matter	**$PM_{2.5}$**	**24 hour**	**40**	**4**	**Currently enforced**
			25	**4**	**1 Jan 2030**
		1 year	**20**	**-**	**Currently enforced**
			15	**-**	**1 Jan 2030**
Ozone	O_3	8 hours (running)	120	11	Currently enforced
Benzene	C_6H_6	1 year	5	-	Currently enforced
Lead	Pb	1 year	0.5	-	Currently enforced
Carbon monoxide	CO	1 hour	30 000	88	Currently enforced
		8 hour (calculated on 1 hour averages)	10 000	11	Currently enforced

2.2 National Regulations for Dust Deposition

South Africa's Draft National Dust Control Regulations were published on the 27 May 2011 with the dust fallout standards passed and subsequently published on the 1st of November 2013 (Government Gazette No. 36974). These are called the National Dust Control Regulations (NDCR). The purpose of the regulations is to prescribe general measures for the control of dust in all areas including residential and light commercial areas. SA NDCRs that were published on the 1st of November 2013. Acceptable dustfall rates according to the regulation are summarised in Table 2-2.

Table 2-2: Acceptable dustfall rates

Restriction Area	Dustfall rate (D) (mg m^{-2} day^{-1}, 30-day average)	Permitted frequency of exceeding dust fall rate
Residential	D < 600	Two within a year, not sequential months.
Non-residential	600 < D < 1 200	Two within a year, not sequential months

The regulation also specifies that the method to be used for measuring dustfall and the guideline for locating sampling points shall be ASTM D1739 (1970), or equivalent method approved by any internationally recognized body. It is important to note that dustfall is assessed for nuisance impact and not inhalation health impact.

2.3 Effect of Dust on Vegetation, Animals and Susceptible Human Receptors

2.3.1 Effects of Particular Matter on Vegetation

Since plants are constantly exposed to air, they are the primary receptors for both gaseous and particulate pollutants of the atmosphere. In terrestrial plant species, the enormous foliar surface area acts as a natural sink for pollutants especially the particulate ones. Vegetation is an effective indicator of the overall impact of air pollution particularly in context of particulate matter (PM) (Rai, 2016).

There are two main types of direct injury that PM pollution can cause on plants: acute and chronic injury. Acute injury results from exposure to a high concentration of gas for a relatively short period and is manifested by clear visible symptoms on the foliage, often in the form of necrotic lesions. While this type of injury is very easy to detect (although not necessarily to diagnose), chronic injury is subtler: it results from prolonged exposure to lower gas concentrations and takes the form of growth and/or yield reductions, often with no clear visible symptoms. Plants that are constantly exposed to environmental pollutants absorb, accumulate and integrate these pollutants into their systems. It reported that depending on their sensitivity level, plants show visible changes which would include alteration in the biochemical processes or accumulation of certain metabolites (Rai, 2016). Pollutants can cause leaf injury, stomatal damage (Ricks and Williams, 1974, Hirano et al., 1995; Naidoo and Chirkoot; 2004; Harmens et al., 2005), premature senescence, decrease photosynthetic activity, disturb membrane permeability (Ernst, 1981; Naidoo and Chirkoot, 2004; Harmens et al., 2005) and reduce growth and yield in sensitive plant species. The long term, low-concentration exposures of air pollution produces harmful impacts on plant leaves without visible injury. Several studies have been conducted to assess the effects of pollution on different aspects of plant life such as overall growth and development, foliar morphology, anatomy, and bio chemical changes (Rai, 2016).

Plant leaves are the primary receptors for both gaseous and PM pollutants of the atmosphere. Before these pollutants enter the leaf tissue, they interact with foliar surface and modify its configuration. Dust deposition on leaf surface, consisting of ultra-fine and coarse particles, showed reduction in plant growth through its effect on leaf gas exchange, flowering and reproduction of plants, number of leaves and leaf area, one of the most common driving variables in growth analyses. Reduction in leaf area and leaf number may be due to decreased leaf production rate and enhanced senescence (Rai, 2016).

The chemical composition of the dust particles can also affect exposed plant tissue and have indirect effects on the soil pH (Spencer, 2001).

To determine the impact of dust deposition on vegetation, two factors are of importance: (i) Does dust accumulate on vegetation surfaces and if it does, what are the factors influencing the rate of deposition (ii) Once the dust has been deposited, what is the impact of the dust on the vegetation? Regarding the first question, there is adequate evidence that dust does accumulate on all types of vegetation. Any type of vegetation causes a change in the local wind fields, increasing turbulence and enhancing the collection efficiency. Vegetation structure alters the rate of dust deposition such that the larger the "collecting elements" (branches and leaves), the lower the impaction efficiency per element. Therefore, for the same volume of tree/shrub canopy, finer leaves will have better collection efficiencies. However, the roughness of the leaves themselves, in particularly the presence of hairs on the leaves and stems, plays a significant role, with venous surfaces increasing deposition of 1-5 µm particles by up to seven-times compared to smooth surfaces. Collection efficiency rises rapidly with particle size; wind tunnel studies show a relationship of deposition velocity on the fourth power of particle size for moderate wind speeds (Tiwary and Colls, 2010). Wind tunnel studies also show that windbreaks or "shelter belts" of three rows of trees have a decrease of between 35 and 56% of the downwind mass transport of inorganic particles.

After deposition onto vegetation, the effect of particulate matter depends on the composition of the dust. South African ambient standards are set in terms of $PM_{2.5}$ and PM_{10} (particulate matter smaller than 2.5 µm and 10 µm aerodynamic diameter) but internationally it is recognised that there are major differences in the chemical composition of the fine PM (the fraction between 0 and 2.5 µm in aerodynamic diameter) and coarse PM (the fraction between 2.5 µm and 10 µm in aerodynamic diameter). The former is often the result of chemical reactions in the atmosphere and may have a high proportion of black carbon, sulfate and nitrate; whereas the latter often consists of primary particles as a result of abrasion, crushing, soil disturbances and wind erosion (Grantz et al., 2003). Sulfate is however often hygroscopic and may exist in significant fractions in coarse PM. This has been shown at the Elandsfontein Eskom air quality monitoring station where the PM_{10} has been shown to vary between 15% (winter) and 49% (spring) sulfate (Alade, 2010). Grantz et al. (op. cit.) however indicate that sulfate is much less phototoxic than gaseous sulfur dioxide and that "it is unusual for injurious levels of particular sulfate to be deposited upon vegetation".

According to the Canadian Environmental Protection Agency (CEPA), generally air pollution adversely affects plants in one of two ways. Either the quantity of output or yield is reduced, or the quality of the product is lowered. The former (invisible) injury results from pollutant impacts on plant physiological or biochemical processes and can lead to significant loss of growth or yield in nutritional quality (e.g. protein content). The latter (visible) may take the form of discolouration of the leaf surface caused by internal cellular damage. Such injury can reduce the market value of agricultural crops for which visual appearance is important (e.g. lettuce and spinach). Visible injury tends to be associated with acute exposures at high pollutant concentrations whilst invisible injury is generally a consequence of chronic exposures to moderately elevated pollutant concentrations. However, given the limited information available, specifically the lack of quantitative dose-effect information, it is not possible to define a reference level for vegetation and particulate matter (CEPA, 1998).

Exposure to a given concentration of airborne PM may therefore lead to widely differing phytotoxic responses, depending on the mix of the deposited particles. The majority of documented toxic effects indicate responses to the chemical composition of the particles. Direct effects have most often been observed around heavily industrialised point sources, but even there, effects are often associated with the chemistry of the particulate rather than with the mass of particulate. A review of European studies has shown the potential for reduced growth and photosynthetic activity in sunflower and cotton plants exposed to dust fall rates greater than 400 mg/m²/day. Little direct evidence of the effects of dust-fall on South African vegetation, including crops, exists.

2.3.2 Effects of Particulate Matter on Animals

As presented by the Canadian Environmental Protection Agency (CEPA, 1998) studies using experimental animals have not provided convincing evidence of particle toxicity at ambient levels. Acute exposures (4-6 hour single exposures) of laboratory animals to a variety of types of particles, almost always at concentrations well above those occurring in the environment have been shown to cause:

- decreases in ventilatory lung function;
- changes in mucociliary clearance of particles from the lower respiratory tract (front line of defence in the conducting airways);
- increased number of alveolar macrophages and polymorphonuclear leukocytes in the alveoli (primary line of defence of the alveolar region against inhaled particles);
- alterations in immunologic responses (particle composition a factor, since particles with known cytotoxic properties, such as metals, affect the immune system to a significantly greater degree);
- changes in airway defence mechanisms against microbial infections (appears to be related to particle composition and not strictly a particle effect);
- increase or decrease in the ability of macrophages to phagocytize particles (also related to particle composition);
- a range of histologic, cellular and biochemical disturbances, including the production of proinflammatory cytokines and other mediators by the lungs alveolar macrophages (may be related to particle size, with greater effects occurring with ultrafine particles);
- increased electrocardiographic abnormalities (an indication of cardiovascular disturbance); and
- increased mortality.

Bronchial hypersensitivity to non-specific stimuli, and increased morbidity and mortality from cardio-respiratory symptoms, are most likely to occur in animals with pre-existing cardio-respiratory diseases. Sub-chronic and chronic exposure tests involved repeated exposures for at least half the lifetime of the test species. Particle mass concentrations to which test animals were exposed were very high (> 1 mg m^{-3}), greatly exceeding levels reported in the ambient environment. Exposure resulted in significant compromises in various lung functions similar to those seen in the acute studies, but including also:

- reductions in lung clearance;
- induction of histopathologic and cytologic changes (regardless of particle types, mass, concentration, duration of exposure or species examined);
- development of chronic alveolitis and fibrosis; and
- development of lung cancer (a particle and/or chemical effect).

The epidemiological finding of an association between 24-hour ambient particle levels below 100 µg/m³ and mortality has not been substantiated by animal studies as far as PM_{10} and $PM_{2.5}$ are concerned. At ambient concentrations, none of the other particle types and sizes used in animal inhalation studies result in acute effects, including high mortality, with exception of ultrafine particles (0.1 µm). The lowest concentration of $PM_{2.5}$ reported that caused acute death in rats with acute pulmonary inflammation or chronic bronchitis was 250 g/m³ (3 days, 6 hour/day), using continuous exposure to concentrated ambient particles.

Most of the literature regarding air quality impacts on cattle refers to the impacts from feedlots on the surrounding environment, hence where the feedlot is seen as the source of pollution. This mainly pertains to odours and dust generation.

The US-EPA recently focussed on the control of air pollution from feed yards and dairies, primarily regulating coarse particulate matter. However, the link between particulates and public health is considered to be understudied (Sneeringer, 2009).

A study was conducted by the State University of Iowa on the effects of air contaminants and emissions on animal health in swine facilities. Air pollutants included gases, particulates, bioaerosols, and toxic microbial by-products. The main findings were that ammonia is associated with lowered average number of pigs weaned, arthritis, porcine stress syndrome, muscle lesions, abscesses, and liver ascarid scars. Particulates are associated with the reduction in growth and turbine pathology, and bioaerosols could lower feed efficiency, decrease growth, and increase morbidity and mortality. The authors highlighted the general lack of information on the health effects and productivity-problems of air contaminants on cattle and other livestock. Ammonia and hydrogen sulfide are regarded the two most important inorganic gases affecting the respiratory system of cattle raised in confinement facilities, affecting the mucociliary transport and alveolar macrophage functions. Holland et al., (2002) found that the fine inhalable particulate fraction is mainly derived from dried faecal dust.

Inhalation of confinement-house dust and gases produces a complex set of respiratory responses. An individual's response depends on characteristics of the inhaled components (such as composition, particle size and antigenicity) and of the individual's susceptibility, which is tempered by extant respiratory conditions (Davidson et al., 2005). Most studies concurred that the main implication of dusty environments is the stress caused to animals which is detrimental to their general health. However, no threshold levels exist to indicate at what levels these are having a negative effect. In this light it was decided to use the same screening criteria applied to human health, i.e. the South African Standards and SANS limit values.

2.3.3 Effect of Particulate Matter on Susceptible Human Receptors

The impact of particles on human health is largely depended on (i) particle characteristics, particularly particle size and chemical composition, and (ii) the duration, frequency and magnitude of exposure. The potential of particles to be inhaled and deposited in the lung is a function of the aerodynamic characteristics of particles in flow streams. The aerodynamic properties of particles are related to their size, shape and density. The deposition of particles in different regions of the respiratory system depends on their size.

The nasal openings permit very large dust particles to enter the nasal region, along with much finer airborne particulates. These larger particles are deposited in the nasal region by impaction on the hairs of the nose or at the bends of the nasal passages. The smaller particles (PM_{10}) pass through the nasal region and are deposited in the tracheobronchial and pulmonary regions. Then particles are removed by impacting with the wall of the bronchi when they are unable to follow the gaseous streamline flow through subsequent bifurcations of the bronchial tree. As the airflow decreases near the terminal bronchi, the smallest particles are removed by Brownian motion, which pushes them to the alveolar membrane (CEPA, 1998; Dockery and Pope, 1994).

The air quality guidelines for particulates are given for various particle size fractions, including total suspended particulates (TSP), thoracic particulates or PM_{10}, and respirable particulates or $PM_{2.5}$. Although TSP is defined as all particulates with an aerodynamic diameter of less than 100 µm, and effective upper limit of 30 µm aerodynamic diameter is frequently assigned. The PM_{10} and $PM_{2.5}$ are of concern due to their health impact potentials. As indicated previously, such fine particles are deposited in, and damage the lower airways and gas-exchanging portions of the lung.

The World Health Organization states that the evidence on airborne particulates and public health consistently shows adverse health effects at exposures experienced by urban populations throughout the world. The range of effects is broad, affecting the respiratory and cardiovascular systems and extending from children to adults including large susceptible groups within the general population. Long-term exposure to particulate matter has been found to have adverse effects on human respiratory health (Abbey et al., 1995). Respiratory symptoms in children resident in an industrialised city were initially found not to be associated with long-term exposure to particulate matter; however non-asthmatic symptoms and hospitalizations did increase with increased total suspended particulate concentrations (Hruba et al., 2001). Subsequently, epidemiological evidence shows adverse effects of particles after both short-term and long-term exposures. Current scientific evidence indicates that guidelines cannot be proposed that will lead to complete protection against adverse health effects as thresholds (or no adverse effect levels (NOAEL) have not been identified.

Many scientific studies have linked inhaled particulate matter to a series of significant health problems, including:

- aggravated asthma and associated hospitalisation or emergence department admission, even for coarse particulate ($PM_{2.5}$ to PM_{10}) (Keet et al 2017);
- hospital admissions for respiratory and cardiovascular diseases associated with fine particulate ($PM_{2.5}$) exposure, even at levels consistently below limit values (Makar et al 2017)
- kidney, bladder and colorectal cancer (Turner et al 2017)
- ischaemic heart disease (Lim et al 2015)
- increases in respiratory symptoms like coughing and difficult or painful breathing;
- chronic bronchitis;
- decreased lung function; and,
- premature death.

PM_{10} is the standard measure of particulate air pollution used worldwide and studies suggest that asthma symptoms can be worsened by increases in the levels of PM_{10}, which is a complex mixture of particle types. PM_{10} has many components and there is no general agreement regarding which component(s) could exacerbate asthma. However, pro-inflammatory effects of transition metals, hydrocarbons, ultrafine particles (due to combustion processes) and endotoxins - all present to varying degrees in PM_{10} - could be important.

Exposure to motor traffic emissions can have a significant effect on respiratory function in children and adults. Studies show that children living near heavily travelled roadways have significantly higher rates of wheezing and diagnosed asthma. Epidemiologic studies suggest that children may be particularly susceptible to diesel exhaust.

2.4 Regulations regarding Air Dispersion Modelling

Air dispersion modelling provides a cost-effective means for assessing the impact of air emission sources, the major focus of which is to determine compliance with the relevant ambient air quality standards. Regulations regarding Air Dispersion Modelling were promulgated in Government Gazette No. 37804 vol. 589; 11 July 2014, (DEA, 2014) and recommend a suite of dispersion models to be applied for regulatory practices as well as guidance on modelling input requirements, protocols and procedures to be followed. The Regulations regarding Air Dispersion Modelling are applicable –

(a) in the development of an air quality management plan, as contemplated in Chapter 3 of the Air Quality Act (AQA);
(b) in the development of a priority area air quality management plan, as contemplated in section 19 of the AQA;
(c) in the development of an atmospheric impact report, as contemplated in section 30 of the AQA; and,
(d) in the development of a specialist air quality impact assessment study, as contemplated in Chapter 5 of the AQA.

The Regulations have been applied to the development of this report. The first step in the dispersion modelling exercise requires a clear objective of the modelling exercise and thereby gives direction to the choice of the dispersion model most suited for the purpose. Chapter 2 of the Regulations present the typical levels of assessments, technical summaries of the prescribed models (SCREEN3, AERSCREEN, AERMOD, SCIPUFF, and CALPUFF) and good practice steps to be taken for modelling applications. The proposed operation falls under a Level 2 assessment – described as follows;

- The distribution of pollutants concentrations and depositions are required in time and space.
- Pollutant dispersion can be reasonably treated by a straight-line, steady-state, Gaussian plume model with first order chemical transformation. The model specifically to be used in the air quality impact assessment of the proposed operation is AERMOD.
- Emissions are from sources where the greatest impacts are in the order of a few kilometres (less than 50 km) downwind.

Dispersion modelling provides a versatile means of assessing various emission options for the management of emissions from existing or proposed installations. Chapter 3 of the Regulations prescribe the source data input to be used in the models. Dispersion modelling can typically be used in the:

- Apportionment of individual sources for installations with multiple sources. In this way, the individual contribution of each source to the maximum ambient predicted concentration can be determined. This may be extended to the study of cumulative impact assessments where modelling can be used to model numerous installations and to investigate the impact of individual installations and sources on the maximum ambient pollutant concentrations.
- Analysis of ground level concentration changes as a result of different release conditions (e.g. by changing stack heights, diameters and operating conditions such as exit gas velocity and temperatures).
- Assessment of variable emissions as a result of process variations, start-up, shut-down or abnormal operations.
- Specification and planning of ambient air monitoring programs which, in addition to the location of sensitive receptors, are often based on the prediction of air quality hotspots.

The above options can be used to determine the most cost-effective strategy for compliance with the NAAQS. Dispersion models are particularly useful under circumstances where the maximum ambient concentration approaches the ambient air quality limit value and provide a means for establishing the preferred combination of mitigation measures that may be required including:

- Stack height increases;
- Reduction in pollutant emissions through the use of air pollution control systems (APCS) or process variations;
- Switching from continuous to non-continuous process operations or from full to partial load.

Chapter 4 of the Regulations prescribe meteorological data input from onsite observations to simulated meteorological data. The chapter also gives information on how missing data and calm conditions are to be treated in modelling applications. Meteorology is fundamental for the dispersion of pollutants because it is the primary factor determining the diluting effect of the atmosphere. Therefore, it is important that meteorology is carefully considered when modelling.

Topography is also an important geophysical parameter. The presence of terrain can lead to significantly higher ambient concentrations than would occur in the absence of the terrain feature. In particular, where there is a significant relative difference in elevation between the source and off-site receptors large ground level concentrations can result. Thus the accurate determination of terrain elevations in air dispersion models is very important.

The modelling domain would normally be decided on the expected zone of influence; the latter extent being defined by the predicted ground level concentrations from initial model runs. The modelling domain must include all areas where the ground level concentration is significant when compared to the air quality limit value (or other guideline). Air dispersion models require a receptor grid at which ground-level concentrations can be calculated. The receptor grid size should include the entire modelling domain to ensure that the maximum ground-level concentration is captured and the grid resolution (distance between grid points) sufficiently small to ensure that areas of maximum impact adequately covered. No receptors however should be located within the property line as health and safety legislation (rather than ambient air quality standards) is applicable within the site.

Chapter 5 provides general guidance on geophysical data, model domain and coordinates system required in dispersion modelling, whereas Chapter 6 elaborates more on these parameters as well as the inclusion of background air concentration data. The chapter also provides guidance on the treatment of NO_2 formation from NO_x emissions, chemical transformation of sulfur dioxide into sulfates and deposition processes.

Chapter 7 of the Regulations outline how the plan of study and modelling assessment reports are to be presented to authorities.

2.5 Highveld Priority Area

The Highveld Airshed Priority Area (HPA) in which the Arnot Power Station is located, was declared the second national air quality priority area (after the Vaal Triangle Airshed Priority Area) by the Minister of Environmental Affairs at the end of 2007 (HPA, 2011) due to elevated particulate and SO_2 concentrations in the area. This required that an Air Quality Management Plan for the area be developed. The plan includes the establishment of emissions reduction strategies and intervention programmes based on the findings of a baseline characterisation of the area. The implication of this is that all contributing sources in the area will be assessed to determine the emission reduction targets to be achieved over the following few years.

The DEA published the management plan for the Highveld Priority Area in September 2011. Included in this management plan are seven goals, each of which has a further list of objectives that has to be met. The seven goals for the Highveld Priority area are as follows:

- **Goal 1:** By 2015, organisational capacity in government is optimised to efficiently and effectively maintain, monitor and enforce compliance with ambient air quality standards.
- **Goal 2:** By 2020, industrial emissions are equitably reduced to achieve compliance with ambient air quality standards and dust fall-out limit values.
- **Goal 3:** By 2020, air quality in all low-income settlements is in full compliance with ambient air quality standards.
- **Goal 4:** By 2020, all vehicles comply with the requirements of the National Vehicle Emission Strategy.
- **Goal 5:** By 2020, a measurable increase in awareness and knowledge of air quality exists.
- **Goal 6:** By 2020, biomass burning and agricultural emissions will be 30% less than current.
- **Goal 7:** By 2020, emissions from waste management are 40% less than current.

3 RECEIVING ENVIRONMENT

3.1 Site Description

The proposed project will be located south of the existing Arnot Power Station ash facility on one of two potential sites (i.e. Alternative 1 or Alternative 2) (Figure 1-3). The closest residential area to the proposed project is Rietkuil, immediately north of the existing Arnot Power Station ash facility. Individual farmsteads also surround the project area.

3.2 Climate and Atmospheric Dispersion Potential

Meteorological mechanisms direct the dispersion, transformation and eventual removal of pollutants from the atmosphere. The extent to which pollution will accumulate or disperse in the atmosphere is dependent on the degree of thermal and mechanical turbulence within the earth's boundary layer. This dispersion comprises vertical and horizontal components of motion. The stability of the atmosphere and the depth of the surface-mixing layer define the vertical component. The horizontal dispersion of pollution in the boundary layer is primarily a function of the wind field. The wind speed determines both the distance of downwind transport and the rate of dilution as a result of plume 'stretching'. The generation of mechanical turbulence is similarly a function of the wind speed, in combination with the surface roughness. The wind direction, and the variability in wind direction, determines the general path pollutants will follow, and the extent of crosswind spreading. The pollution concentration levels therefore fluctuate in response to changes in atmospheric stability, to concurrent variations in the mixing depth, and to shifts in the wind field (Tiwary and Colls, 2010).

The spatial variations, and diurnal and seasonal changes, in the wind field and stability regime are functions of atmospheric processes operating at various temporal and spatial scales (Goldreich and Tyson, 1988). The atmospheric processes at macro- and meso-scales need therefore be taken into account in order to accurately parameterise the atmospheric dispersion potential of a particular area. A qualitative description of the synoptic systems determining the macro-ventilation potential of the region may be provided based on the review of pertinent literature. These meso-scale systems may be investigated through the analysis of meteorological data observed for the region.

Since no weather measurements are available from the proposed site, meteorological information was obtained from MM5 modelled data for the period 2013 to 2015.

3.2.1 Local Wind Field

The vertical dispersion of pollution is largely a function of the wind field. The wind speed determines both the distance of downward transport and the rate of dilution of pollutants. The generation of mechanical turbulence is similarly a function of the wind speed, in combination with the surface roughness (Tiwary and Colls, 2010).

The wind roses comprise 16 spokes, which represent the directions from which winds blew during a specific period. The colours used in the wind roses below, reflect the different categories of wind speeds; the yellow area, for example, representing winds in between 5 and 7 m/s. The dotted circles provide information regarding the frequency of occurrence of wind speed and direction categories. The frequency with which calms occurred, i.e. periods during which the wind speed was below 1 m/s are also indicated.

The period wind field and diurnal variability in the wind field are shown in Figure 3-1, while the seasonal variations are shown in Figure 3-2. The wind regime for the area is dominated by easterly and northwesterly flow fields. The northwesterly wind flow is more dominant during day-time conditions, with easterly wind flow more dominant during the night. Calm conditions occurred 11.2 % of the period summarised.

Seasonally, the wind flow pattern conforms to the period average wind flow pattern; however, some seasonal variability in the wind fields (Figure 3-2). During summer easterly winds are more frequent than in other seasons, while winds from the north-west occur more frequently in winter. Autumn has the highest frequency of calm periods (16%) while spring shows an increased frequency of winds of speeds greater than 5 m/s.

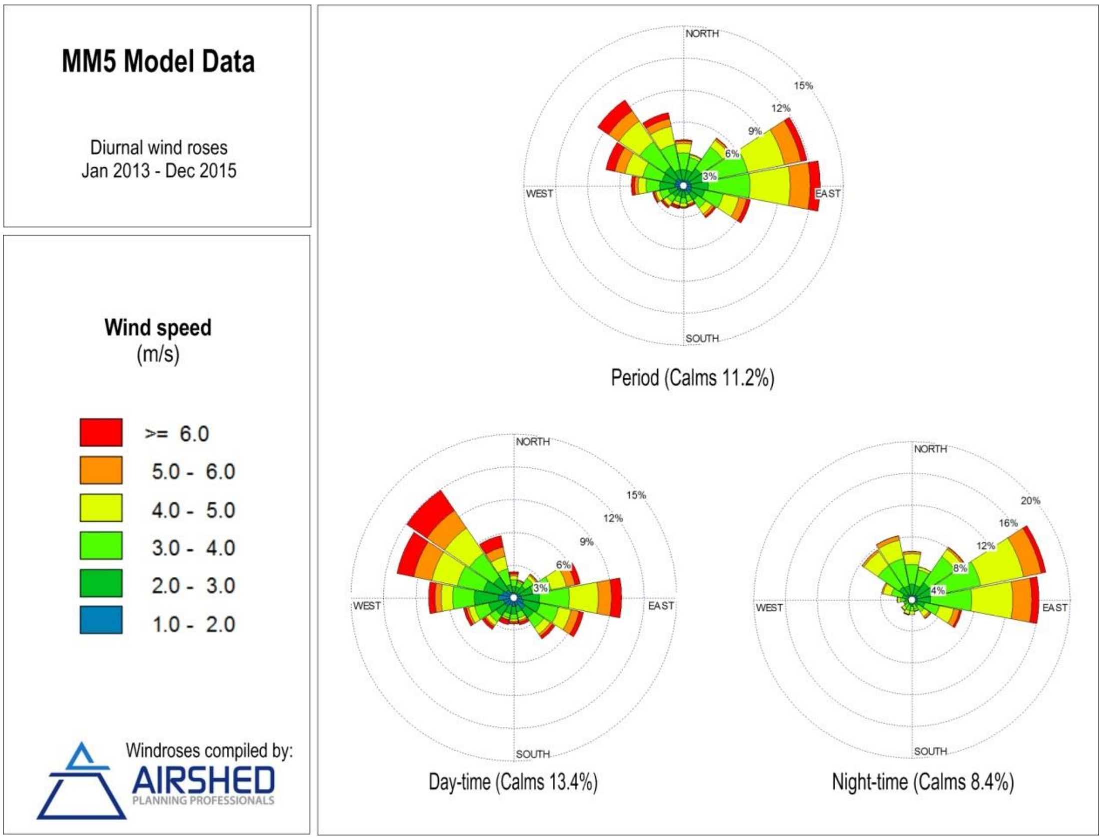


Figure 3-1: Period, day-, and night-time wind roses (MM5 data, January 2013 to December 2015)

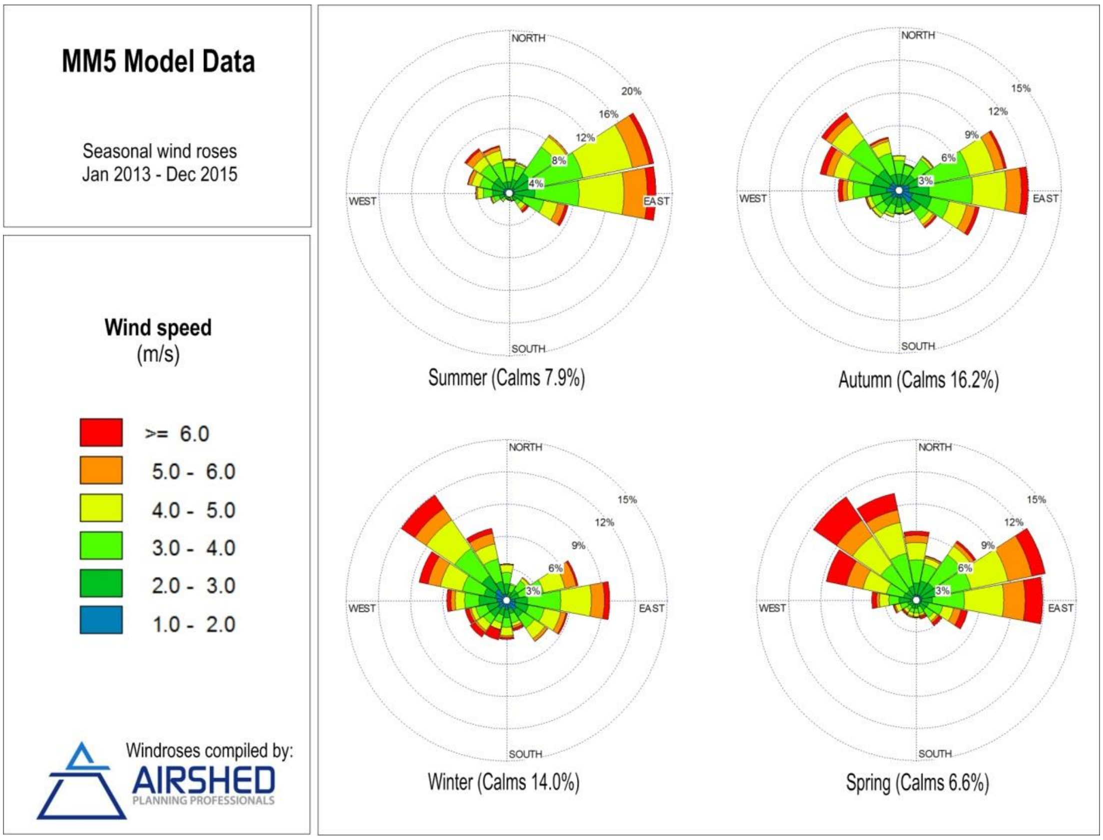


Figure 3-2: Seasonal wind roses (MM5 data, January 2013 to December 2015)

3.2.2 Ambient Temperature

Air temperature is important, both for determining the effect of plume buoyancy (the larger the temperature difference between the emission plume and the ambient air, the higher the plume is able to rise), and determining the development of the mixing and inversion layers.

Monthly mean, maximum and minimum temperatures are given in Table 3-1. Diurnal temperature variability is presented in Figure 3-3. Temperatures ranged between -3.0°C and 29.5°C. During the day, temperatures increase to reach maximum at about 15:00 in the late afternoon. Ambient air temperature decreases to reach a minimum at between 06:00 and 07:00.

Table 3-1: Monthly temperature summary (MM5 data, January 2013 to December 2015)

Monthly Minimum, Maximum and Average Temperatures (°C)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minimum	14.5	14.3	13.1	9.5	6.9	4.6	4.4	6.5	9.9	11.1	12.9	14.9
Average	19.4	19.3	17.7	14.2	11.7	9.0	8.6	11.1	14.7	16.2	18.0	19.6
Maximum	25.0	25.1	23.0	19.6	17.2	14.6	14.0	16.6	20.3	22.0	23.5	24.7

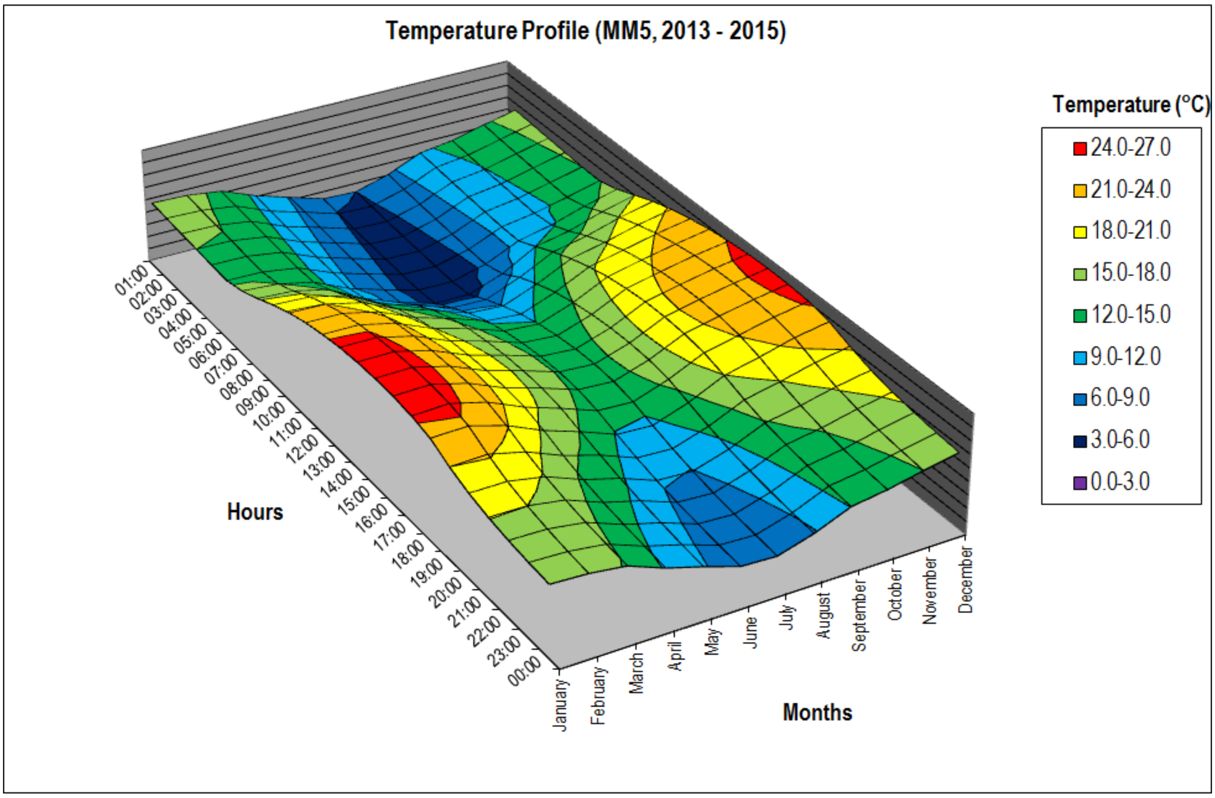
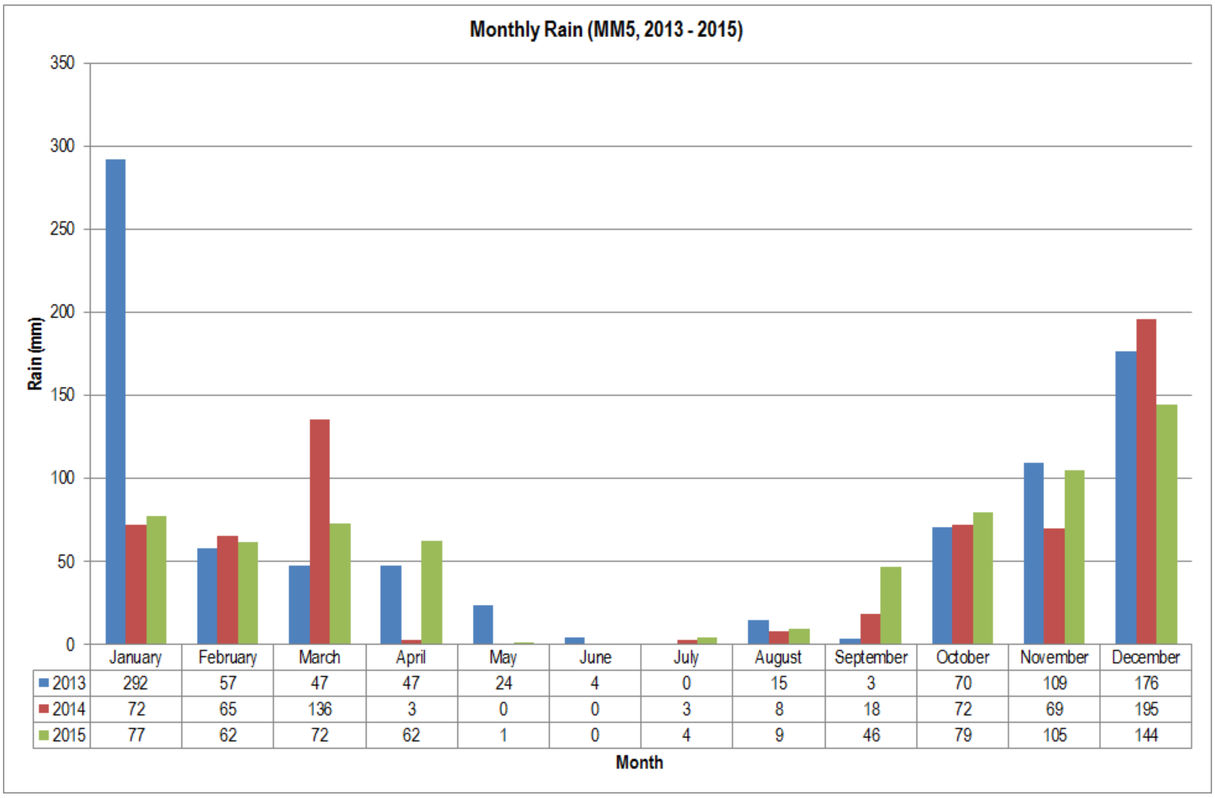


Figure 3-3: Diurnal temperature profile (MM5 data, January 2013 to December 2015)

3.2.3 Precipitation

Precipitation represents an effective removal mechanism of atmospheric pollutants. Precipitation reduces wind erosion potential by increasing the moisture content of materials. Rain-days are defined as days experiencing 0.1 mm or more rainfall. Moderate showers (usually of short duration) commonly occur in spring and summer (October to March). The rainfall provided by the MM5 data set for the period 2013 to 2015 ranged between 640 and 845 mm per year (Figure 3-4).



	January	February	March	April	May	June	July	August	September	October	November	December
🟦 2013	292	57	47	47	24	4	0	15	3	70	109	176
🟥 2014	72	65	136	3	0	0	3	8	18	72	69	195
🟩 2015	77	62	72	62	1	0	4	9	46	79	105	144

Figure 3-4: Monthly rainfall as obtained from the MM5 data for the area (2013-2015)

3.2.4 Atmospheric Stability and Mixing Depth

The new generation air dispersion models differ from the models traditionally used in a number of aspects, the most important of which are the description of atmospheric stability as a continuum rather than discrete classes. The atmospheric boundary layer properties are therefore described by two parameters; the boundary layer depth and the Monin-Obukhov length, rather than in terms of the single parameter Pasquill Class. The Monin-Obukhov length (LMo) provides a measure of the importance of buoyancy generated by the heating of the ground and mechanical mixing generated by the frictional effect of the earth's surface. Physically, it can be thought of as representing the depth of the boundary layer within which mechanical mixing is the dominant form of turbulence generation (CERC, 2004). The atmospheric boundary layer constitutes the first few hundred metres of the atmosphere. During the daytime, the atmospheric boundary layer is characterised by thermal turbulence due to the heating of the earth's surface. Night times are characterised by weak vertical mixing and the predominance of a stable layer. These conditions are normally associated with low wind speeds and less dilution potential. During windy and/or cloudy conditions, the atmosphere is normally neutral. For low level releases, the highest ground level concentrations would occur during weak wind speeds and stable (night-time) atmospheric conditions. Diurnal variation in atmospheric stability for the site is provided in Figure 3-5.

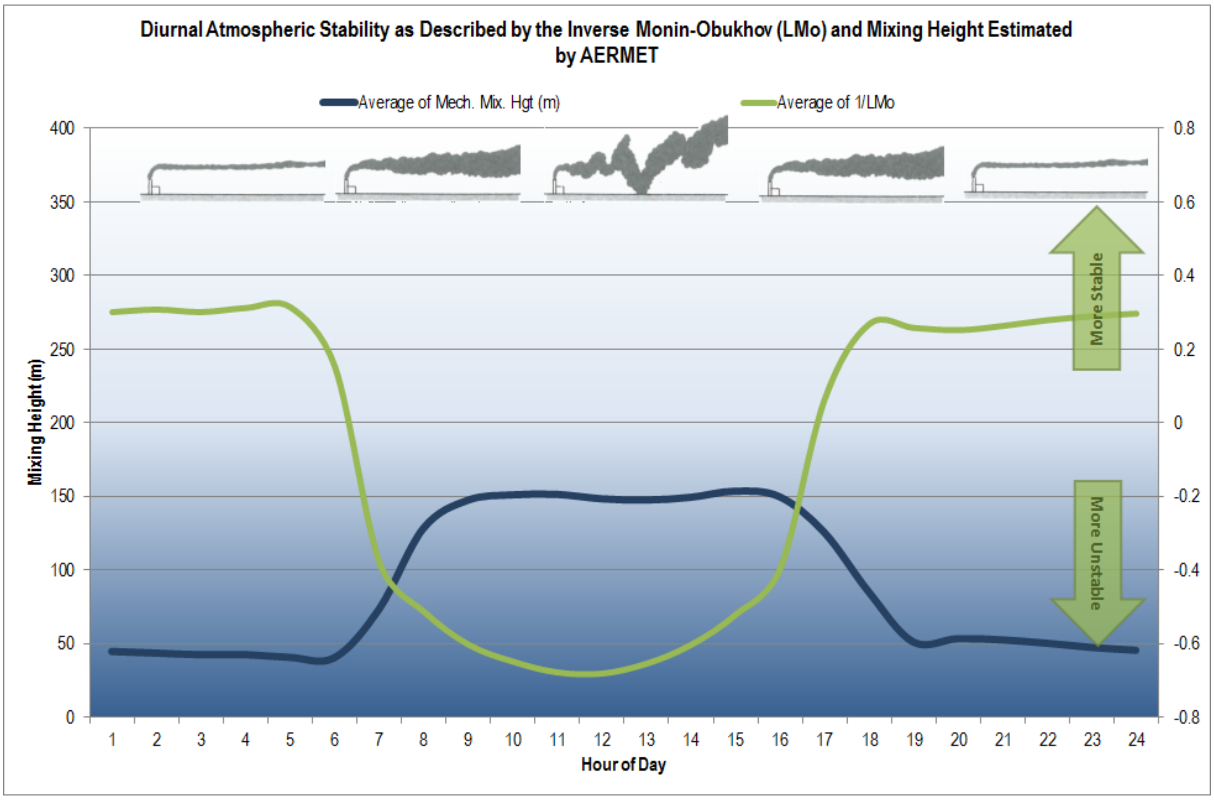


Figure 3-5: Average diurnal atmospheric stability as calculated by Aermet from MM5 data for the period 2013 – 2015

3.3 Ambient Air Quality within the Region

The Department of Environmental Affairs (DEA) operates a monitoring network over the Highveld region at the residential areas of Hendrina (actual location in Kwazamokuhle, just northeast of Hendrina), Ermelo, Middleburg, Secunda and eMalahleni. The closest monitoring station to the proposed operations is located at Hendrina approximately 18 km southwest. The highest daily PM_{10} and $PM_{2.5}$ concentrations for the period May 2016 to May 2018 are given in Figure 3-6 and Figure 3-7 respectively. The measured daily PM_{10} and $PM_{2.5}$ ground level concentrations at the DEA operated Hendrina monitoring station is within current NAAQS for the period May 2016 to May 2018.

Eskom operates a monitoring station (Kwazamokuhle) less than 1km from the DEA operated Hendrina monitoring station. Monitored data from this site was downloaded for the period May 2016 to May 2018 and measures more than 4 exceedances of the daily PM_{10} NAAQS and daily $PM_{2.5}$ NAAQS. Measured PM_{10} and $PM_{2.5}$ thus exceeds daily NAAQS at this monitoring site.

It should be noted that measured PM_{10} and $PM_{2.5}$ concentrations at the DEA operated Hendrina and Eskom operated Kwazamokuhle sites may be influenced by local sources of emissions and may not be representative of ambient air quality at the proposed project site approximately 18 km to the northeast.

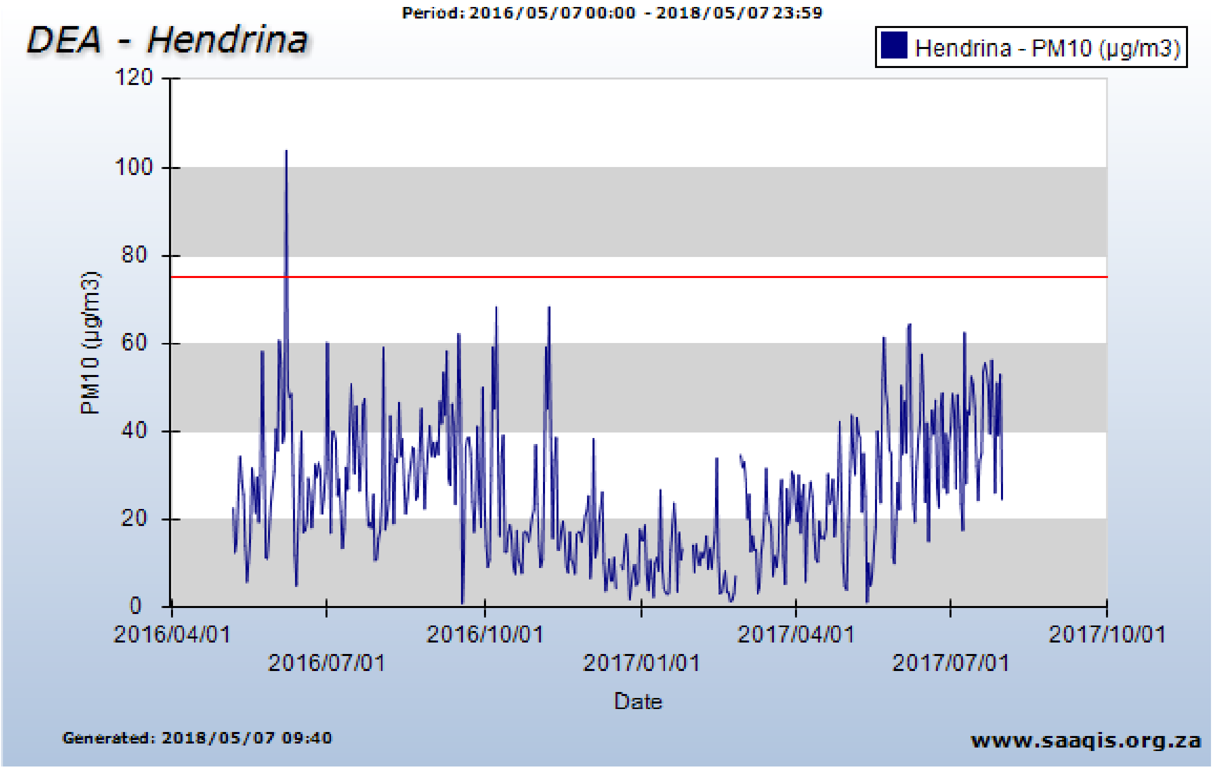


Figure 3-6: Daily measured PM_{10} ground level concentrations (µg/m³) at the Hendrina DEA monitoring station (for the period May 2016 to May 2018) (as downloaded from the SAAQIS website on 7 May 2018)

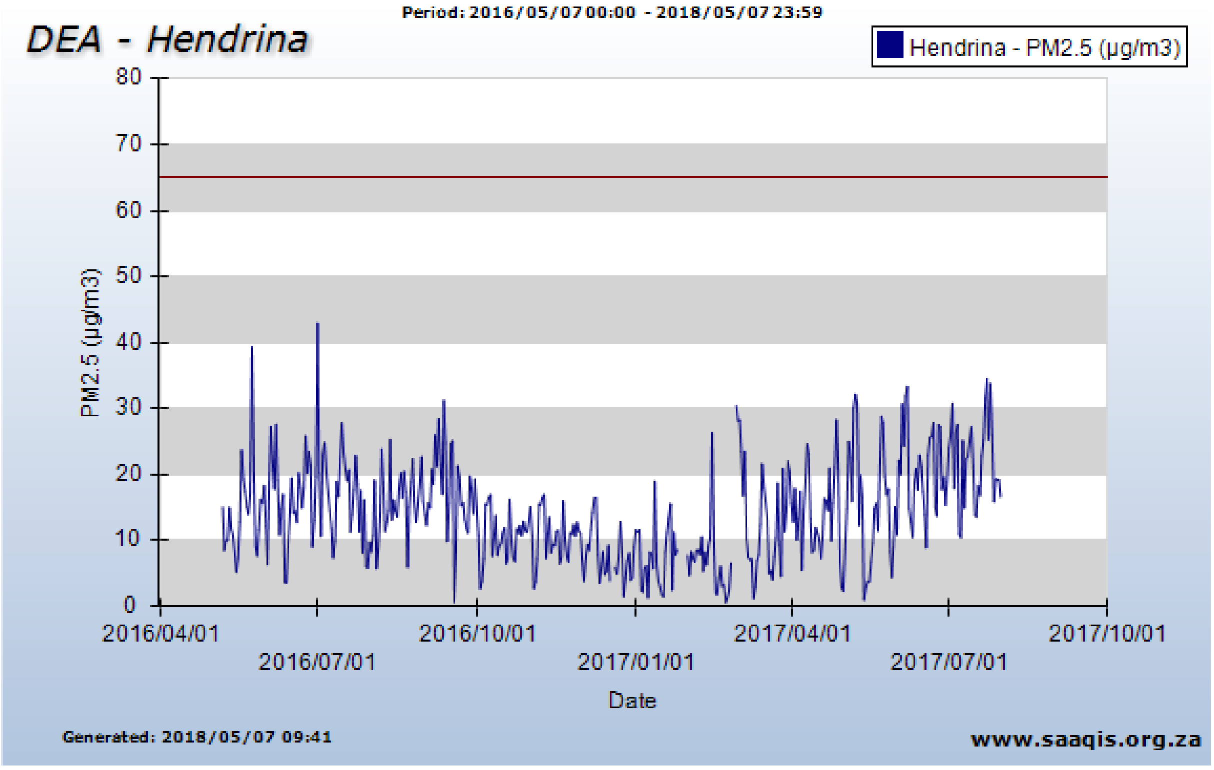


Figure 3-7: Daily measured $PM_{2.5}$ ground level concentrations (µg/m³) at the Hendrina DEA monitoring station (for the period May 2016 to May 2018) (as downloaded from the SAAQIS website on 7 May 2018)

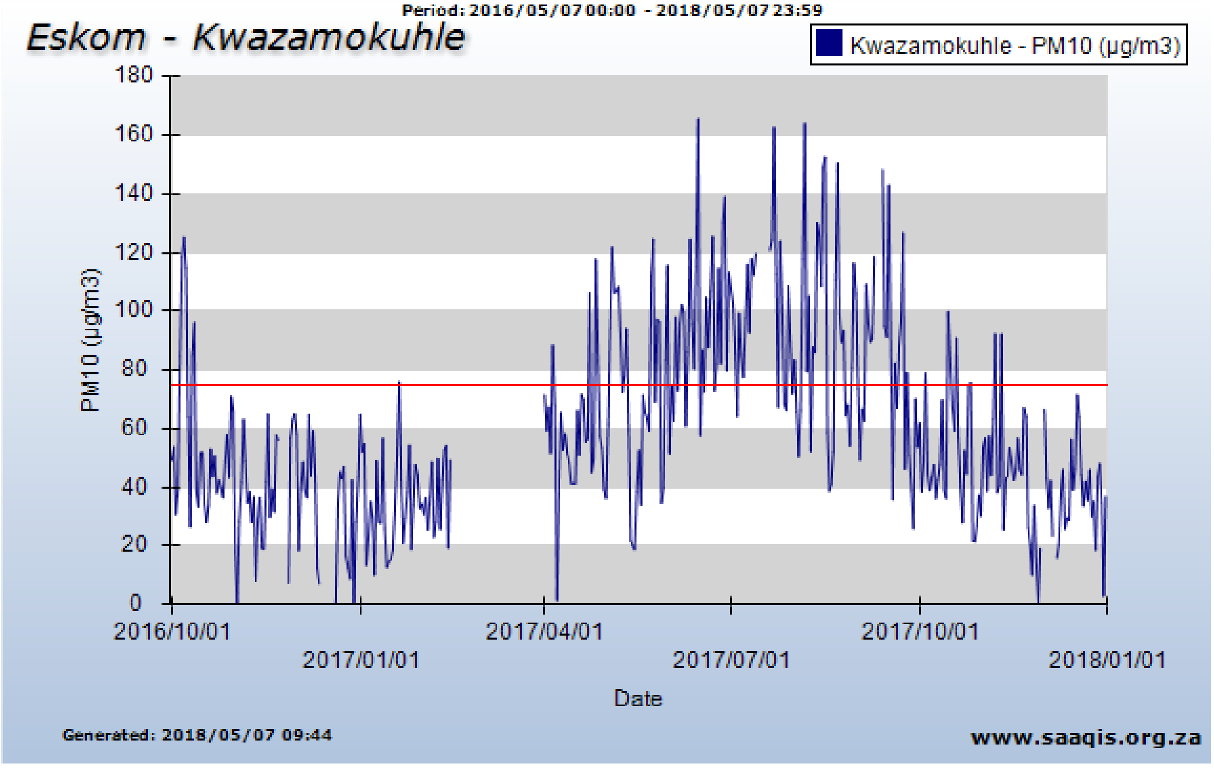


Figure 3-8: Daily measured PM_{10} ground level concentrations (µg/m³) at the Eskom operated Kwazamokuhle monitoring station (for the period May 2016 to May 2018) (as downloaded from the SAAQIS website on 7 May 2018)

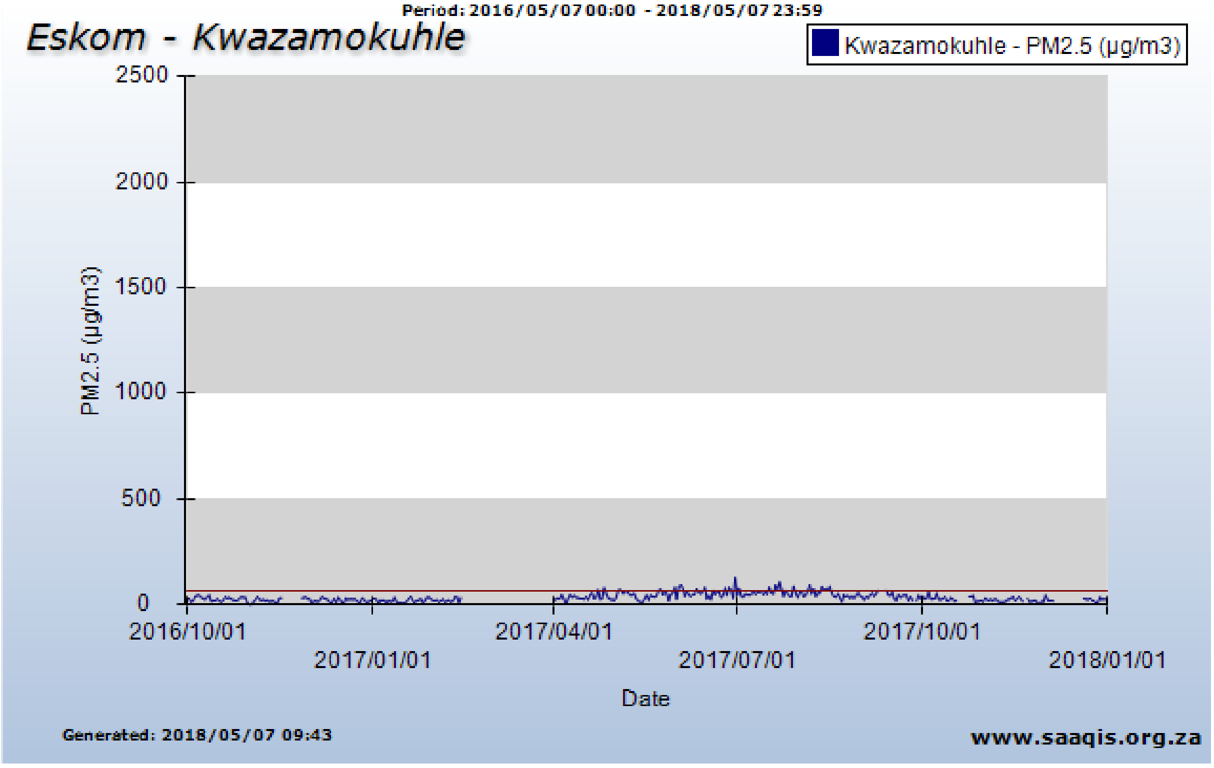


Figure 3-9: Daily measured $PM_{2.5}$ ground level concentrations (µg/m³) at the Eskom operated Kwazamokuhle monitoring station (for the period May 2016 to May 2018) (as downloaded from the SAAQIS website on 7 May 2018)

3.4 Existing Sources of Emissions near the Proposed Project

The main existing sources of particulate emissions in the area are mining activities, agricultural activities and vehicle entrainment.

Gaseous emissions (viz. SO_2, CO, carbon dioxide (CO_2), oxides of nitrogen (NO_x) and hydrocarbons) will derive from combustions sources such as vehicles and power station activity.

The main contribution from these sources can be summarised as follows:

- Power station operations near the project site (i.e. Arnot Power Station) will contribute to CO_2, SO_2, CO, PM_{10}, $PM_{2.5}$ and NO_x gaseous emissions. The existing ash facility at the power station will contribute to particulate matter though windblown dust if the facility is not completely rehabilitated once the new facility is operational.
- Numerous coal mines are located near the Arnot Power Station (particularly to the west of operations). Particulate matter is the main pollutant of concern from mining operations deriving from materials handling, vehicle entrainment and crushing activities.
- Agriculture (together with mining) is a dominant land-use within the surrounding area. Particulate matter is the main pollutant of concern from agricultural activities as particulate emissions are deriving from windblown dust, burning crop residue, and dust entrainment as a result of vehicles travelling along dirt roads. In addition, pollen grains, mold spores and plant and insect parts from agricultural activities all contribute to the particulate load (WHO, 2000).
- Biomass burning results in aerosols, black carbon and hydrocarbons. Biomass burning is also a significant source of greenhouse gases, especially CO_2 and methane (CH_4), black carbon and photochemical gases (NO_x, CO and hydrocarbons) that lead to the production of tropospheric O_3. The extent of NO_x emissions depends on combustion temperatures, with minor sulfur oxides being released. Burning crop residue may be a significant source of atmospheric emissions within the area.
- Household fuel burning contributes to gaseous and particulate ambient concentrations. Coal burning emits a large amount of gaseous and particulate pollutants including SO_2, NO_2, heavy metals, total and respirable particulates including heavy metals and inorganic ash, carbon monoxide, polycyclic aromatic hydrocarbons, and benzo(a)pyrene (EPA, 1996). Polyaromatic hydrocarbons are recognised as carcinogens. Pollutants arising due to the combustion of wood include respirable particulates, SO_2, NO_2, carbon monoxide, polycyclic aromatic hydrocarbons, particulate benzo(a)pyrene and formaldehyde (EPA, 1996). The main pollutants emitted from the combustion of paraffin are NO_2, particulates carbon monoxide and polycyclic aromatic hydrocarbons (EPA, 2010).
- Vehicle tailpipe emissions can be significant sources of CO_2, CO, hydrocarbons (HCs), SO_2, NO_x and particulate matter.

3.5 Identification of Possible Sensitive Receptors in the Area

The NAAQS (detailed in Section 2.1) are based on human exposure to specific criteria pollutants and as such, possible sensitive receptors were identified where the public is likely to be unwittingly exposed. NAAQS are enforceable outside of project operational boundaries and therefore the sensitive receptors identified include the residential areas within a 5 km radius of the three proposed ash disposal facility alternatives (as indicated in Figure 3-1). Potential impacts from the proposed project will be assessed at these sensitive receptors and screened against NAAQS.

4 DESCRIPTION OF POTENTIAL IMPACTS

The project includes the disposal of ash from the Arnot Power Station at a new ash disposal (~120 ha in size). The main pollutant of concern associated with the proposed operations is particulate matter. Particulates are divided into different particle size categories with TSP associated with nuisance impacts and the finer fractions of PM_{10} (particulates with a diameter less than 10 µm) and $PM_{2.5}$ (diameter less than 2.5 µm) linked with potential health impacts. PM_{10} is primarily associated with mechanically generated dust whereas $PM_{2.5}$ is associated with combustion sources. Gaseous pollutants (such as SO_2, NO_x, CO, etc.) derive from vehicle exhausts and other combustions sources. These are however insignificant in relation to the particulate emissions.

The establishment of the ash disposal facility will result in particulate emissions (listed in Table 4-1) during the following operations:

- Land preparation during establishment and progression of the ash disposal facility;
- Freshly exposed topsoil, as a step in rehabilitation of the ash disposal facility, that will be prone to wind erosion before establishment of vegetation; and,
- Movement of vehicles across exposed soil or ash, will also be a source of pollution.

The subsequent sections provide a generic description of the parameters influencing dust generation from the various aspects identified.

Table 4-1: Activities and aspects identified for the construction, operational and closure phases of the proposed operations

Pollutant(s)	Aspect	Activity
Construction		
Particulates	Construction of progressing ash disposal facility site	Clearing of groundcover
		Levelling of area
		Wind erosion from topsoil storage piles
		Tipping of topsoil to storage pile
	Vehicle activity on-site	Vehicle and construction equipment activity during construction operations
Gases and particles	Vehicle and construction equipment activity	Tailpipe emissions from vehicles and construction equipment such as graders, scrapers and dozers
Continuous ash disposal		
Particulates	Wind erosion from ash disposal facility	Exposed dried out portions of the ash disposal facility
	Vehicle activity on-site	Vehicle activity at the ash disposal facility
Gases and particles	Vehicle activity	Tailpipe emissions from vehicle activity at the ash disposal facility
Rehabilitation		
Particulates	Rehabilitation of ash disposal facility	Topsoil recovered from stockpiles
		Tipping of topsoil onto ash disposal facility
	Wind erosion	Exposed cleared areas and exposed topsoil during rehabilitation
	Vehicle activity on unpaved roads and on-site	Truck activity at site during rehabilitation
Gases and	Vehicle activity	Tailpipe emissions from trucks and equipment used for rehabilitation

Pollutant(s)	Aspect	Activity
particles		

4.1 Construction phase

The construction phase is relevant as the ash disposal facility is established and during continuous ash disposal, as this would normally comprise a series of different operations including land clearing, topsoil removal, road grading, material loading and hauling, stockpiling, compaction, etc. Each of these operations has a distinct duration and potential for dust generation. It is anticipated that the extent of dust emissions would vary substantially from day to day depending on the level of activity, the specific operations, and the prevailing meteorological conditions.

It is not anticipated that the various construction activities will result in higher off-site impacts than the operational activities. The temporary nature of the construction activities, and the likelihood that these activities will be localised and for small areas at a time, will reduce the potential for significant off-site impacts. The Australian Environmental Protection Agency recommends a buffer zone of 300 m from the nearest sensitive receptor when extractive-type materials handling activities occur (AEPA, 2007).

4.2 Continuous ash disposal

Wind erosion is a complex process, including three different phases of particle entrainment, transport and deposition. It is primarily influenced by atmospheric conditions (e.g. wind, precipitation and temperature), soil properties (e.g. soil texture, composition and aggregation), land-surface characteristics (e.g. topography, moisture, aerodynamic roughness length, vegetation and non-erodible elements) and land-use practice (e.g. farming, grazing and mining) (Shao, 2008).

Windblown dust generates from natural and anthropogenic sources. For wind erosion to occur, the wind speed needs to exceed a certain threshold, called the threshold velocity. This relates to gravity and the inter-particle cohesion that resists removal. Surface properties such as soil texture, soil moisture and vegetation cover influence the removal potential. Conversely, the friction velocity or wind shear at the surface is related to atmospheric flow conditions and surface aerodynamic properties. Thus, for particles to become airborne the wind shear at the surface must exceed the gravitational and cohesive forces acting upon them, called the threshold friction velocity (Shao, 2008).

Estimating the amount of windblown particles to be generated from the proposed ash disposal facility is not a trivial task and requires detailed information on the particle size distribution, moisture content, silt content and bulk density. Dust will only be generated under conditions of high wind speeds and from areas where the material is exposed and has dried out (US-EPA, 1995).

4.3 Rehabilitation

If rehabilitation is planned to occur continuously throughout the disposal of ash, including the removal and tipping of topsoil onto the completed ash disposal facility surface areas, dust may be generated from the dried out exposed ash surfaces before it is covered with topsoil. Once vegetation is established the potential for dust generation will reduce significantly. The tipping of topsoil and vehicle entrainment on associated unpaved roads will also result in dust generation.

It is assumed that all ash disposal activities will have ceased during closure phase, when the power station has reached end of life. If most of the rehabilitation is undertaken during the operations, the ash disposal facility should be almost completely rehabilitated by the closure phase. The potential for impacts after closure will depend on the extent of continuous rehabilitation efforts on the ash disposal facility.

The significance of the rehabilitation activities is likely to be linked to impacts from windblown dust from the exposed dried out ash, topsoil and vehicle entrainment during the rehabilitation process. Windblown dust is likely to only impact off-site under conditions of high wind speed with no mitigation in place. If rehabilitation as indicated takes place, i.e. vegetation cover, the impacts should be limited to be within the site boundary. As vegetation cover increases, the potential for wind erosion will decrease.

5 SIGNIFICANCE RANKING

2014 EIA Regulations require that impacts be assessed in the scoping phase in terms of the nature, significance, consequence, extent, duration and probability of the impacts including the degree to which these impacts can be reversed, may cause irreplaceable loss of resources, and can be avoided, managed or mitigated. The significance ranking methodology used in this scoping report is provided in Appendix A - EIMS Environmental Impact Assessment significance rating methodology.

The two alternative 120 ha sites were considered (Figure 1-3). The significance ranking of Alternative 1 and Alternative 2 will be similar as the impacts offsite will be comparable in magnitude and spatial distribution. The impacts for the two alternatives have therefore been provided together for the construction (Table 5-1), operations (Table 5-2) and decommissioning phases (Table 5-3). Due to the location of sensitive receptors to the proposed project sites, both alternatives are likely to impact on the same number of receptors so there is no clear preferable site.

Table 5-1: Significance Ranking Summary for Construction

Impact Name	**Degraded Ambient Air Quality**				
Alternative	**Alternative 1, Alternative 2**				
Phase	**Construction**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	3	2
Extent of Impact	2	2	Reversibility of Impact	2	2
Duration of Impact	2	2	Probability	3	2
Environmental Risk (Pre-mitigation)					-6.75
Mitigation Measures					
Maintenance of vehicles and wet suppression or chemical treatment on unpaved road surfaces. *Wet suppression on disturbed areas where feasible.* *Minimise extent of disturbed areas.* *Reduction of frequency of disturbance.* *Early re-vegetation* *Stabilisation (chemical, rock cladding or vegetative) of disturbed soil*					
Environmental Risk (Post-mitigation)					-4.00
Degree of confidence in impact prediction:					Low
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					2
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					2
The impact may result in the irreplaceable loss (cannot be replaced or substituted) of resources but the value (services and/or functions) of these resources is limited.					
Prioritisation Factor					1.33
Final Significance					-5.33

Table 5-2: Significance Ranking Summary for Operation

Impact Name	**Degraded Ambient Air Quality**				
Alternative	**Alternative 1, Alternative 2**				
Phase	**Operation**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	4	3
Extent of Impact	3	3	Reversibility of Impact	3	3
Duration of Impact	4	4	Probability	3	3
Environmental Risk (Pre-mitigation)					-10.50
Mitigation Measures					
A potentially significant impacting source may be wind erosion from the ash dams during periods of high winds (>9m/s). It is recommended that the sidewalls of the ash dams be vegetated. The vegetation cover should be such to ensure at least 80% control efficiency. The top surface area should have 40% wet beach area (if feasible and if wet deposition option is considered) and a water spraying system should be implemented on the surface of the ash dam covering the outer perimeter of the dam, spraying water when winds exceed 4 m/s.					
Environmental Risk (Post-mitigation)					-9.75
Degree of confidence in impact prediction:					Low
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					2
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					2
The impact may result in the irreplaceable loss (cannot be replaced or substituted) of resources but the value (services and/or functions) of these resources is limited.					
Prioritisation Factor					1.33
Final Significance					-13.00

Table 5-3: Significance Ranking Summary for Decommissioning

Impact Name	**Degraded Ambient Air Quality**				
Alternative	**Alternative 1, Alternative 2**				
Phase	**Decommissioning**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	3	2
Extent of Impact	2	2	Reversibility of Impact	2	2
Duration of Impact	3	3	Probability	3	2
Environmental Risk (Pre-mitigation)					-7.50
Mitigation Measures					
For long-term control measures vegetation frequently represents the most cost-effective and efficient control.					
Environmental Risk (Post-mitigation)					-4.50
Degree of confidence in impact prediction:					Low
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					2
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					2
The impact may result in the irreplaceable loss (cannot be replaced or substituted) of resources but the value (services and/or functions) of these resources is limited.					
Prioritisation Factor					1.33
Final Significance					-6.00

6 PLAN OF STUDY FOR THE IMPACT ASSESSMENT

The main findings from the scoping level assessment were as follows:

- The flow field is dominated by winds from the east and northwestern sectors. During day-time conditions, winds from the northwest are more frequent, with winds from the easterly sector increasing at night.
- The closest residential area to the proposed project is Rietkuil, north of the existing Arnot Power Station ash facility. Individual farmsteads also surround the project area.
- Criteria pollutants emitted during the proposed project operations will include particulate matter.
- Due to the location of sensitive receptors to the proposed project sites, both alternatives are likely to impact on the same number of receptors so there is no clear preferable site.

The main aim of this investigation was to provide the basis for the air quality impact assessment plan to be conducted for the proposed project. The following will be included in the impact assessment study:

- Compilation of an emissions inventory, comprising the identification and quantification of potential sources of emissions due to the proposed project;
- Dispersion simulations of particulate matter from the proposed project for applicable averaging periods;
- Evaluation of potential for human health and environmental impacts; and,
- Determination of environmental risk according to stipulated Impact Assessment methodology.

7 ASSUMPTIONS AND UNCERTAINTIES

The following assumptions apply to the scoping assessment conducted;

- No on-site meteorological data are available. Use was therefore made of modelled MM5 meteorological data for the period 2013-2015.
- The modelling guidelines stipulate that three years of off-site meteorological data should be used from a period no older than five years to the year of assessment. As the onset of the Air Quality Assessment was in 2016, meteorological data for the period 2013 – 2015 was used. Presently four months falls outside of the last five-year period. This limitation is not found to be significant, however, as the meteorological conditions within the study area have not shown any significant historical changes.
- Measured ambient data is not available at the proposed project site. The closest monitoring stations operated by DEA (Hendrina) and Eskom (Kwazamokuhle) are located approximately 18 km southwest of the site. The measured ambient air quality at these sites may thus not be representative of ambient air quality at the proposed project site.

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APPENDIX A - EIMS ENVIRONMENTAL IMPACT ASSESSMENT SIGNIFICANCE RATING METHODOLOGY

THE IMPACT ASSESSMENT METHODOLOGY

Method of Assessing Impacts:

The impact assessment methodology is guided by the requirements of the NEMA EIA Regulations (2010). The broad approach to the significance rating methodology is to determine the environmental risk (ER) by considering the consequence (C) of each impact (comprising Nature, Extent, Duration, Magnitude, and Reversibility) and relate this to the probability/likelihood (P) of the impact occurring. This determines the environmental risk. In addition other factors, including cumulative impacts, public concern, and potential for irreplaceable loss of resources, are used to determine a prioritisation factor (PF) which is applied to the ER to determine the overall significance (S). Please note that the impact assessment must apply to the identified Sub Station alternatives as well as the identified Transmission line routes.

Determination of Environmental Risk:

The significance (S) of an impact is determined by applying a prioritisation factor (PF) to the environmental risk (ER).

The environmental risk is dependent on the consequence (C) of the particular impact and the probability (P) of the impact occurring. Consequence is determined through the consideration of the Nature (N), Extent (E), Duration (D), Magnitude (M), and reversibility (R) applicable to the specific impact.

For the purpose of this methodology the consequence of the impact is represented by:

$$C = \frac{E+D+M+R}{4} \times N$$

Each individual aspect in the determination of the consequence is represented by a rating scale as defined in Table A-1.

Table A-1: Criteria for Determining Impact Consequence

Aspect	Score	Definition
Nature	- 1	Likely to result in a negative/ detrimental impact
	+1	Likely to result in a positive/ beneficial impact
Extent	1	Activity (i.e. limited to the area applicable to the specific activity)
	2	Site (i.e. within the development property boundary),

Aspect	Score	Definition
	3	Local (i.e. the area within 5 km of the site),
	4	Regional (i.e. extends between 5 and 50 km from the site
	5	Provincial / National (i.e. extends beyond 50 km from the site)
Duration	1	Immediate (<1 year)
	2	Short term (1-5 years),
	3	Medium term (6-15 years),
	4	Long term (the impact will cease after the operational life span of the project),
	5	Permanent (no mitigation measure of natural process will reduce the impact after construction).
Magnitude/ Intensity	1	Minor (where the impact affects the environment in such a way that natural, cultural and social functions and processes are not affected),
	2	Low (where the impact affects the environment in such a way that natural, cultural and social functions and processes are slightly affected),
	3	Moderate (where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way),
	4	High (where natural, cultural or social functions or processes are altered to the extent that it will temporarily cease), or
	5	Very high / don't know (where natural, cultural or social functions or processes are altered to the extent that it will permanently cease).
Reversibility	1	Impact is reversible without any time and cost.
	2	Impact is reversible without incurring significant time and cost.
	3	Impact is reversible only by incurring significant time and cost.
	4	Impact is reversible only by incurring prohibitively high time and cost.
	5	Irreversible Impact

Once the C has been determined the ER is determined in accordance with the standard risk assessment relationship by multiplying the C and the P (refer to Table A-2). Probability is rated/scored as per Table A-2.

Table A-2: Probability Scoring

Probability	1	Improbable (the possibility of the impact materialising is very low as a result of design, historic experience, or implementation of adequate corrective actions; <25%),
	2	Low probability (there is a possibility that the impact will occur; >25% and <50%),
	3	Medium probability (the impact may occur; >50% and <75%),
	4	High probability (it is most likely that the impact will occur- > 75% probability), or
	5	Definite (the impact will occur),

The result is a qualitative representation of relative ER associated with the impact. ER is therefore calculated as follows:

ER= C x P

Table A-3: Determination of Environmental Risk

Consequence	5	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5
		1	2	3	4	5
	Probability					

The outcome of the environmental risk assessment will result in a range of scores, ranging from 1 through to 25. These ER scores are then grouped into respective classes as described in Table A-4.

Table A-4: Significance Classes

Environmental Risk Score	
Value	**Description**
< 9	Low (i.e. where this impact is unlikely to be a significant environmental risk),
≥9; <17	Medium (i.e. where the impact could have a significant environmental risk),
≥ 17	High (i.e. where the impact will have a significant environmental risk).

The impact ER will be determined for each impact without relevant management and mitigation measures (pre-mitigation), as well as post implementation of relevant management and mitigation measures (post-mitigation). This allows for a prediction in the degree to which the impact can be managed/mitigated.

Impact Prioritisation:

In accordance with the requirements of Regulation 31 (2)(l) of the EIA Regulations (GNR 543), and further to the assessment criteria presented in the Section above it is necessary to assess each potentially significant impact in terms of:

- Cumulative impacts; and
- The degree to which the impact may cause irreplaceable loss of resources.

In addition it is important that the public opinion and sentiment regarding a prospective development and consequent potential impacts is considered in the decision making process.

In an effort to ensure that these factors are considered, an impact prioritisation factor (PF) will be applied to each impact ER (post-mitigation). This prioritisation factor does not aim to detract from the risk ratings but rather to focus the attention of the decision-making authority on the higher priority/significance issues and impacts. The PF will be applied to the ER score based on the assumption that relevant suggested management/mitigation impacts are implemented.

Table A-5: Criteria for Determining Prioritisation

Public response (PR)	Low (1)	Issue not raised in public response.
	Medium (2)	Issue has received a meaningful and justifiable public response.
	High (3)	Issue has received an intense meaningful and justifiable public response.
Cumulative Impact (CI)	Low (1)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.
	Medium (2)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.
	High (3)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is highly probable/definite that the impact will result in spatial and temporal cumulative change.
Irreplaceable loss of resources (LR)	Low (1)	Where the impact is unlikely to result in irreplaceable loss of resources.
	Medium (2)	Where the impact may result in the irreplaceable loss (cannot be replaced or substituted) of resources but the value (services and/or functions) of these resources is limited.
	High (3)	Where the impact may result in the irreplaceable loss of resources of high value (services and/or functions).

The value for the final impact priority is represented as a single consolidated priority, determined as the sum of each individual criteria represented in Table 11. The impact priority is therefore determined as follows:

Priority = PR + CI + LR

The result is a priority score which ranges from 3 to 9 and a consequent PF ranging from 1 to 2 (Refer to Table A-6).

Table A-6: Determination of Prioritisation Factor

Priority	Ranking	Prioritisation Factor
3	Low	1
4	Medium	1.17
5	Medium	1.33
6	Medium	1.5
7	Medium	1.67
8	Medium	1.83
9	High	2

In order to determine the final impact significance the PF is multiplied by the ER of the post mitigation scoring. The ultimate aim of the PF is to be able to increase the post mitigation environmental risk rating by a full ranking class, if all the priority attributes are high (i.e. if an impact comes out with a medium environmental risk after the conventional impact rating, but there is significant cumulative impact potential, significant public response, and significant potential for irreplaceable loss of resources, then the net result would be to upscale the impact to a high significance).

Table A-7: Final Environmental Significance Rating

Environmental Significance Rating	
Value	**Description**
< 10	Low (i.e. where this impact would not have a direct influence on the decision to develop in the area),
≥10 <20	Medium (i.e. where the impact could influence the decision to develop in the area),
≥ 20	High (i.e. where the impact must have an influence on the decision process to develop in the area).