Air Quality Scoping Report

SolAfrica, Sandraai CSP

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Royal HaskoningDHV

Enhancing Society Together

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Glossary

Ambient air	The air of the surrounding environment.
Baseline	The current and existing condition before any development or action.
Boundary layer	In terms of the earth's planetary boundary layer is the air layer near the ground affected by diurnal heat, moisture or momentum to or from the surface.
Concentration	When a pollutant is measured in ambient air it is referred to as the concentration of that pollutant in air. Pollutant concentrations are measured in ambient air for various reasons, i.e. to determine whether concentrations are exceeding available health risk thresholds (air quality standards); to determine how different sources of pollution contribute to ambient air concentrations in an area; to validate dispersion modelling conducted for an area; to determine how pollutant concentrations fluctuate over time in an area; and to determine the areas with the highest pollution concentrations.
Concentrated solar power	Concentrated solar power (CSP) systems use mirrors or lenses to concentrate a large area of sunlight or solar thermal energy, onto a small area.
Condensation	The change in the physical state of matter from a gaseous into liquid phase.
Dispersion potential	The potential a pollutant has of being transported from the source of emission by wind or upward diffusion. Dispersion potential is determined by wind velocity, wind direction, height of the mixing layer, atmospheric stability, presence of inversion layers and various other meteorological conditions.
Emission	The rate at which a pollutant is emitted from a source of pollution.
Emission Factor	A representative value, relating the quantity of a pollutant to a specific activity resulting in the release of the pollutant to atmosphere.
Evaporation	Process by which water changes from a liquid to a gaseous or vapour phase.
Inversion	An increase of atmospheric temperature with an increase in height.
Mixing layer	The layer of air within which pollutants are mixed by turbulence. Mixing depth is the height of this layer from the earth's surface
Oxides of Nitrogen	Refers to NO and NO_2. The gas is produced during combustion especially at high temperatures.
Particulate matter (PM)	The collective name for fine solid or liquid particles added to the atmosphere by processes at the earth's surface and includes dust, smoke, soot, pollen and soil particles. Particulate matter is classified as a criteria pollutant, thus national air quality standards have been developed in order to protect the public from exposure to the inhalable fractions. PM can be principally characterised as discrete particles spanning several orders of magnitude in size, with inhalable particles falling into the following general size fractions: * PM10 (generally defined as all particles equal to and less than 10 microns in aerodynamic diameter; particles larger than this are not generally deposited in the lung); * PM2.5, also known as fine fraction particles (generally defined as those particles

with an aerodynamic diameter of 2.5 microns or less) ;

- PM10-2.5, also known as coarse fraction particles (generally defined as those particles with an aerodynamic diameter greater than 2.5 microns, but equal to or less than a nominal 10 microns); and
- Ultra fine particles generally defined as those less than 0.1 microns.

Photovoltaic This relates to the production of an electric current at the junction of two substances exposed to light.

Precipitation Ice particles or water droplets large enough to fall at least 100 m below the cloud base before evaporating.

Relative Humidity The vapour content of the air as a percentage of the vapour content needed to saturate air at the same temperature

Sulphur dioxide A colourless, pungent toxic gas formed by the burning of sulphur in the atmosphere. SO_2 is a hazardous air pollutant, used in many industrial processes and is a major contributor to acid rain.

1 INTRODUCTION

Royal HaskoningDHV was commissioned to undertake an Air Quality scoping study for the proposed Concentrated Solar Park (CSP) located in the Kheis Local municipality, Northern Cape (Figure 1-1). The proposed site is located on the Sandraai farm, approximately 7km south from the Eskom substation. The development of the CSP project will entail the construction of 125 MW photovoltaic cells, 150 MW parabolic trough and 150 MW central receiver tower.

This study aims to assist in the development of a scoping study to determine the potential air quality impacts associated during the construction, operation and eventual decommissioning of the site.

As part of the scoping report, a baseline assessment was undertaken which includes a review of available meteorological data to evaluate the prevailing meteorological conditions within the area. The baseline air quality situation was assessed through a review of meteorological data which was obtained from the South African Weather services for the period of Jan 2011 - Dec 2013. During the impact assessment phase, the potential impact of emissions from the proposed project on the surrounding environment will be evaluated through the compilation of an emissions inventory and subsequent dispersion modelling simulations using the AERMOD dispersion model. Comparisons with the South African and relevant international ambient air quality standards will be made to determine exposure risks.

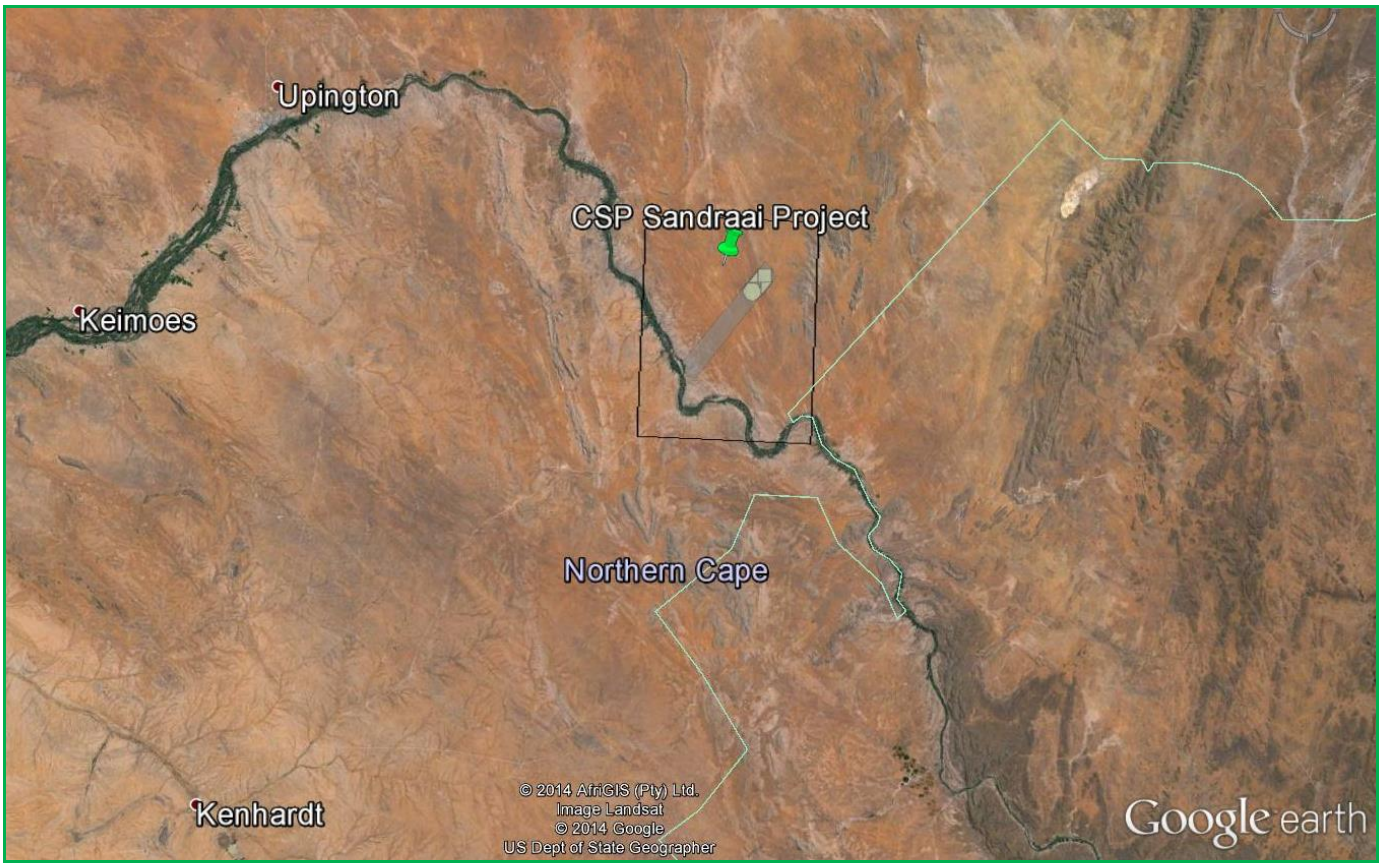


Figure 1-1: Proposed location of the Sandraai Concentrated Solar Park (CSP) project.

1.1 Project Description

Solar power generation is arguably the cleanest, most reliable form of renewable energy available. Concentrated Solar Power (CSP) produces no carbon dioxide (CO_2), thus reducing carbon emission from electricity generation by approximately 100kg per megawatt/hour. CSP technology is based on the principle of converting thermal energy into electrical energy.

Concentrated solar power uses mirrors or lenses to concentrate a large area of sunlight or solar thermal energy onto a small area. Electrical power is produced when the concentrated light is converted to heat, which drives a heat engine, usually a steam turbine connected to an electrical power generator. Concentrating technologies exists in five common forms namely; parabolic trough, enclosed trough, dish sterlings, concentrating linear Fresnel reflectors and solar power tower. Different type of concentrators produces different peak temperatures and correspondingly varying thermodynamic efficiencies due to differences in the way that they track the sun and focus light. The CSP and CPV (concentrated photovoltaic) technologies applicable to the Sandraai project will be discussed in the sections below.

1.1.1 Parabolic trough

A parabolic trough consists of linear parabolic reflectors that concentrate light on to a receiver positioned along the reflectors focal line. The receiver is a tube positioned directly above the middle of the parabolic mirror and filled with a working fluid. The reflectors follow the sun during the daylight hours by tracking along a single axis. A working fluid such as molten salt is heated to 150 – 350 °C as it flows through the receiver and is then used as a heat source for a power generation system. Trough systems are the most developed CSP technology.

Figure 1-2: Example of a parabolic trough system.

1.1.2 Solar Power Tower

A solar power tower consists of an array of dual axis tracking reflectors known as heliostats that concentrate sunlight on a central receiver located at the top of a tower. The receiver contains a fluid deposit which is a salt water solution. The working fluid in the receiver is heated to 500 – 1000 °C and then used as a heat source for power generation or an energy storage system. The power tower development is less developed than the trough systems but it offers a higher efficiency and better energy storage capabilities.

Figure 1-3: Example of a solar power tower system

1.1.3 Concentrated photovoltaic (CPV)

Concentrated photovoltaic (CPV) technology uses optics such as lenses or curved mirrors to concentrate a large amount of sunlight onto a small area of solar photovoltaic cells to generate electricity. In comparison to CSP, CPV systems turn sunlight directly into electricity while solar thermal turns sunlight into heat and then heat into electricity. Solar thermal energy technology is however far more common than CPV although the two technologies are sometimes combined. CPV systems can save money on the cost of the solar cells, since a smaller area of photovoltaic material is required.

Figure 1-4: Example of a Concentrated Photovoltaic system.

1.2 Terms of Reference

The terms of reference for the Air Quality scoping study and impact assessment for the proposed project can be summarised as follows:

- **Baseline Assessment**
  - Provide an overview of the prevailing meteorological conditions in the area;
  - Review applicable legislation and policies related to air quality management which are applicable to the proposed project;
  - Review potential health effects associated with emissions released from the proposed operations;
  - Identification of existing sources of emission and surrounding sensitive receptors, such as local communities, surrounding the study area;
  - Assess the baseline air quality using available ambient air quality monitored data;

- **Impact Assessment**
  - Compilation of an emissions inventory for the proposed air quality related sources identified on site;
  - Dispersion modelling simulations undertaken using AERMOD to determine the potential air quality impacts of the proposed activities on the surrounding area;
  - Comparison of the modelled results to the National ambient air quality standards to determine compliance;
  - Provide recommendations for the implementation of appropriate mitigation measures
  - Compilation of an Air Quality Impact Assessment Report.

1.3 Methodology

An overview of the methodological approach to be followed during this Air Quality Baseline and Atmospheric Impact Assessment is outlined in the section which follows.

1.3.1 Baseline assessment

During the baseline assessment, a qualitative approach was used to assess the baseline conditions in the project area. Local meteorological data was obtained from the South African Weather Services in Upington for the period Jan 2011 – Dec 2013 to determine the atmospheric dispersion potential of the area. Applicable air quality legislation such as the National Environmental Management: Air Quality Act 39 of 2004 (GN163: 2005) and the Listed Activities and Associated Minimum Emission Standards (GN248: 2010) were reviewed. Criteria pollutants relevant to the project and their potential human health effects are also discussed. Existing sources of air pollution surrounding the site were qualitatively assessed. Sensitive receptors, such as local communities in close proximity to the proposed project site were identified via a site visit and through satellite imagery.

1.3.2 Impact assessment

During this phase, an emissions inventory was compiled to estimate emissions from the identified emission sources associated with the proposed activities. Where information is not available, use was made of available United States Environmental Protection Agency (USEPA) emission factors, or emission models to estimate emissions released. Dispersion modelling simulations were undertaken using the AERMOD dispersion model and presented graphically as isopleths plots. Comparison with the National ambient air quality standards (GN263; 2009) was made to determine compliance. Based on the predicted results, recommendations for appropriate mitigation measures were provided.

2 BASELINE DESCRIPTION OF THE AREA

2.1 Meso-Scale Meteorology

The nature of the local climate will determine what will happen to particulates when released into the atmosphere (Tyson & Preston-Whyte, 2000). Concentration 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.

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 & Preston-Whyte, 2000).

Inversion occurs under conditions of stability when a layer of warm air lies 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 & 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 & 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 & Preston-Whyte, 2000).

The meteorological profile of the Northern Cape Province is characterised by hot wet summers from December to February and mild dry winters from July to August. The infrequent summer rains tend to take the form of occasional severe thunderstorms rather than prolonged soft showers.

The hottest month of the year is January with an average temperature ranging from 20 °C – 36 °C, while the coolest month occurs in July with a temperature range of 4 °C – 21 ° C. July is also the driest month of the year with an average rainfall of 2mm.

2.1.1 Wind

Wind roses comprise of 16 spokes which represents the direction from which the winds blew during the period under review. 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 site specific meteorological data obtained from the South African Weather Services in Upington, Northern Cape, the following deductions regarding the prevailing wind direction and wind frequency can be presented.

Based on Figure 2-1 below, the predominant wind direction for the area under review is multidirectional, with primary winds originating from the south-west and northern region. Secondary winds originated mainly from the north western and western regions.

Calms wind (<0.5 m/s) were experienced 6.30 % of the time. High wind speed of 5.7 - 8.8 m/s occurred less frequently than wind speeds of 3.6 - 5.7 m/s which occurred for 25.5 % of the time. The most frequent wid speed of 2.1 - 3.6 m/s were experienced for 36.6 % of the time, while wind speeds of 0.5 -2.1 m/s were experienced for 18.8 % of the time (Figure 2-2).

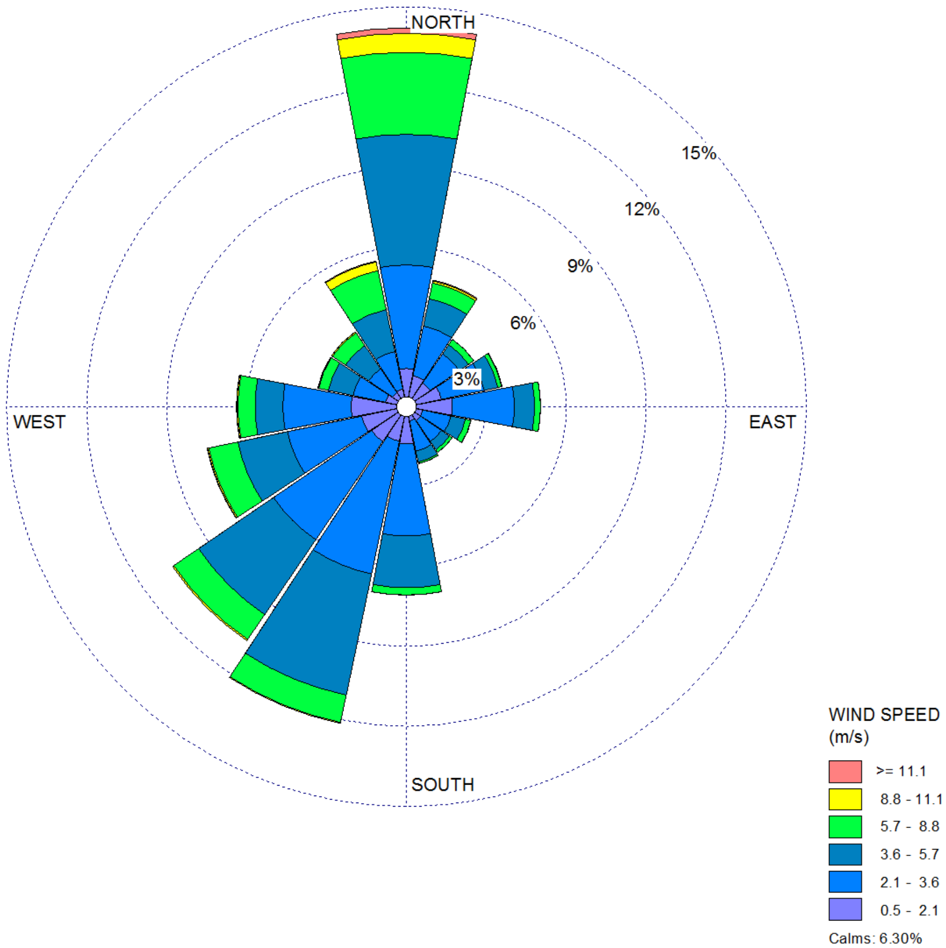


Figure 2-1: Period Wind rose for the Sandraai CSP project area for the Jan 2011 – Dec 2013 monitoring period.

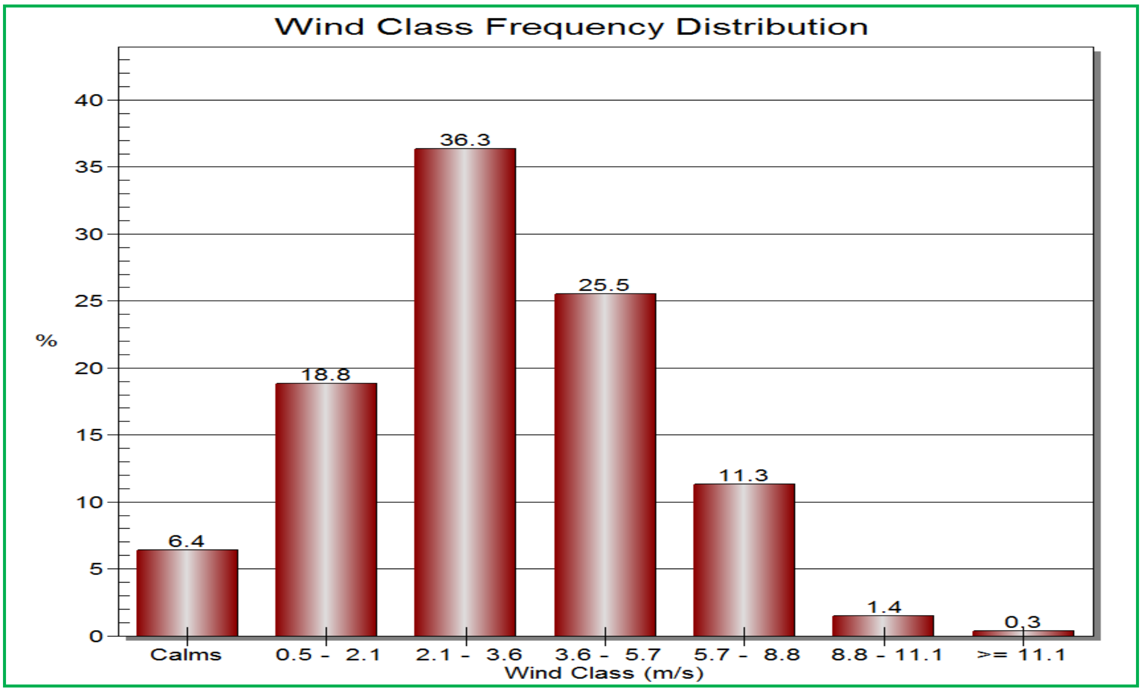
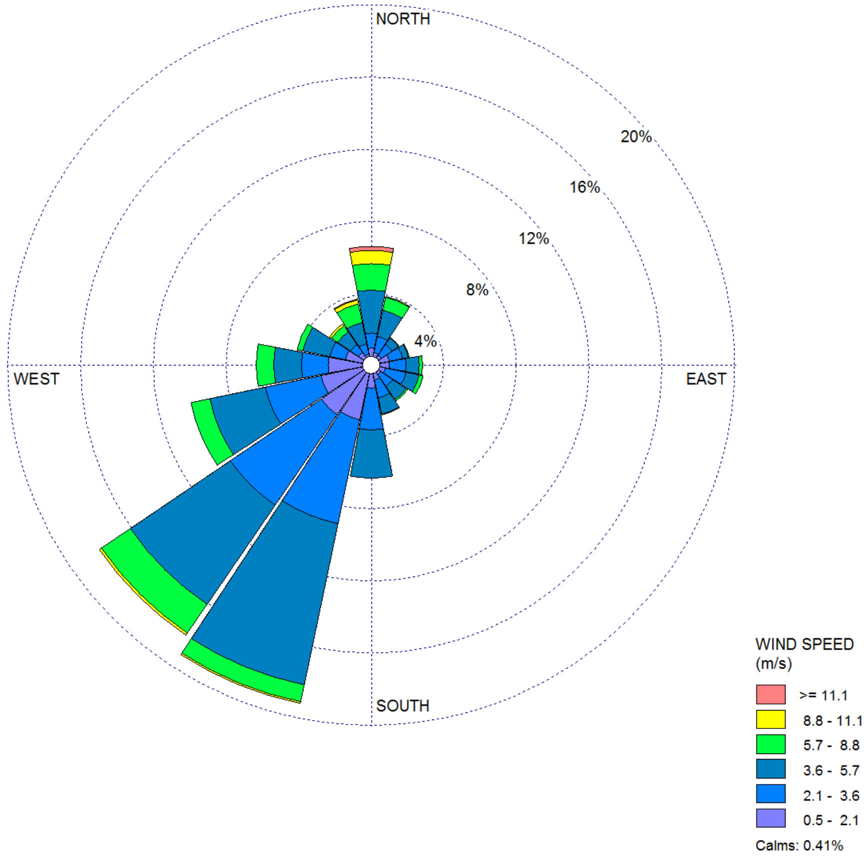


Figure 2-2: Wind class frequency distribution

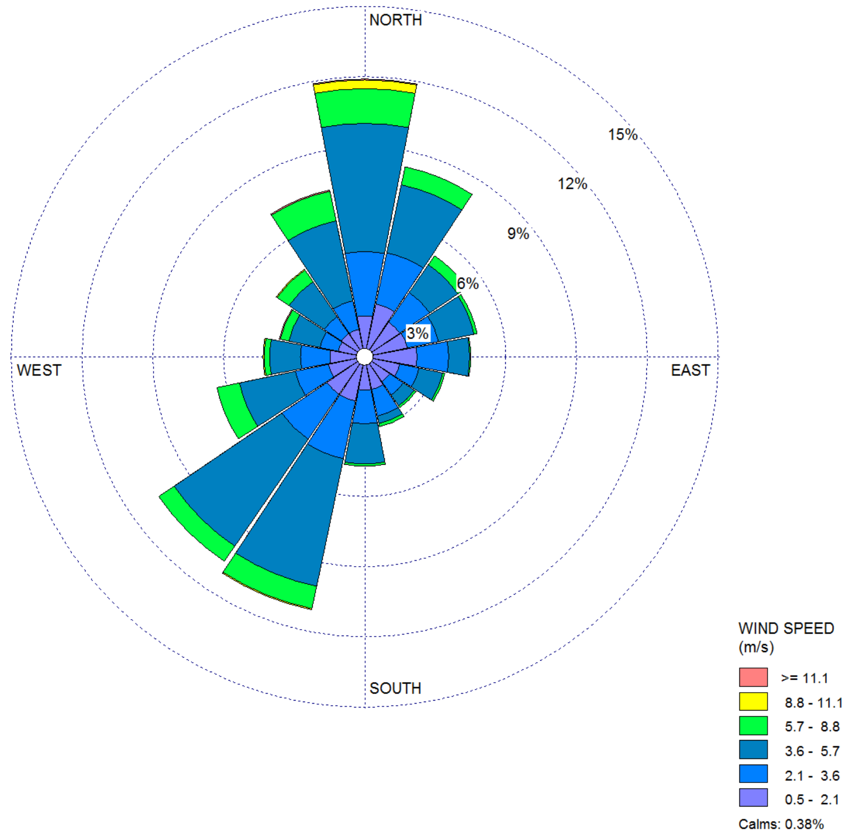
Seasonal variability in the wind field at the proposed site is shown in Figure 2-3 and Figure 2-4 below. During the spring months (September, October and November) the predominant wind direction originated mainly from the South western region. A slight shift in the wind field occurs during the summer months (December, January and February) with a predominant wind direction from the north and south western region, while secondary winds occurred from the north western region.

The autumn (March, April and May) and winter (June, July and August) wind field experienced a similar wind profile, with a predominant wind direction from the north region and secondary winds from the south western and western regions.

Diurnal trends in the wind field for the proposed CSP project is presented in Figure 2-5 and Figure 2-6. Between the 00:00 – 06:00, winds originate predominately from the northern and south western regions, with secondary winds from the north eastern region. A slight shift in the wind profile is observed during the morning hours (06:00 -12:00) towards the north western, west and south west region. During the afternoon and early evening (12:00 -18:00), winds originate predominately from the North West and south western region. A similar wind profile is observed during the evening (18:00- 00:00), slow to moderate winds originate from the south western and north western regions, with secondary winds from the northern region.

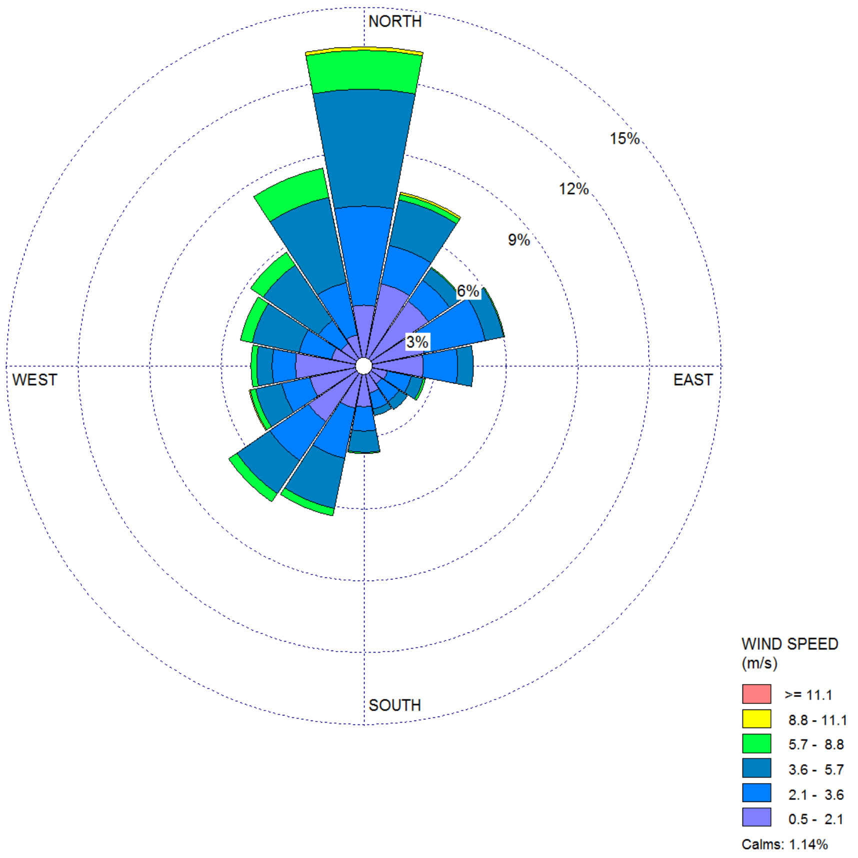


Spring

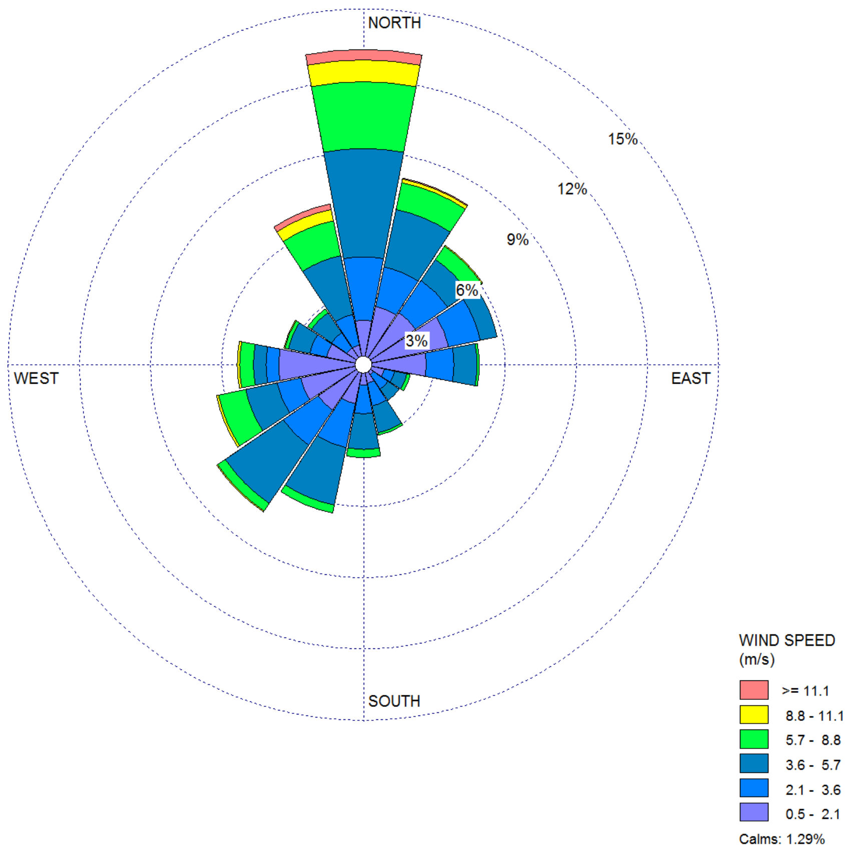


Summer

Figure 2-3: Seasonal wind roses (spring and summer) for the Jan 2011 – Dec 2013 monitoring period.

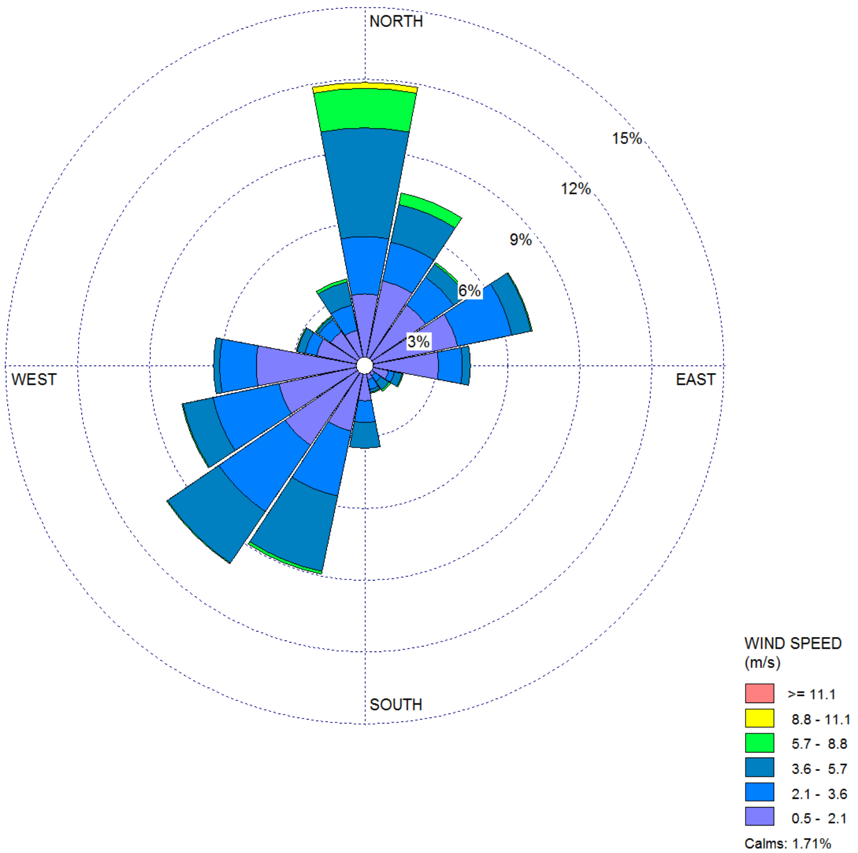


Autumn

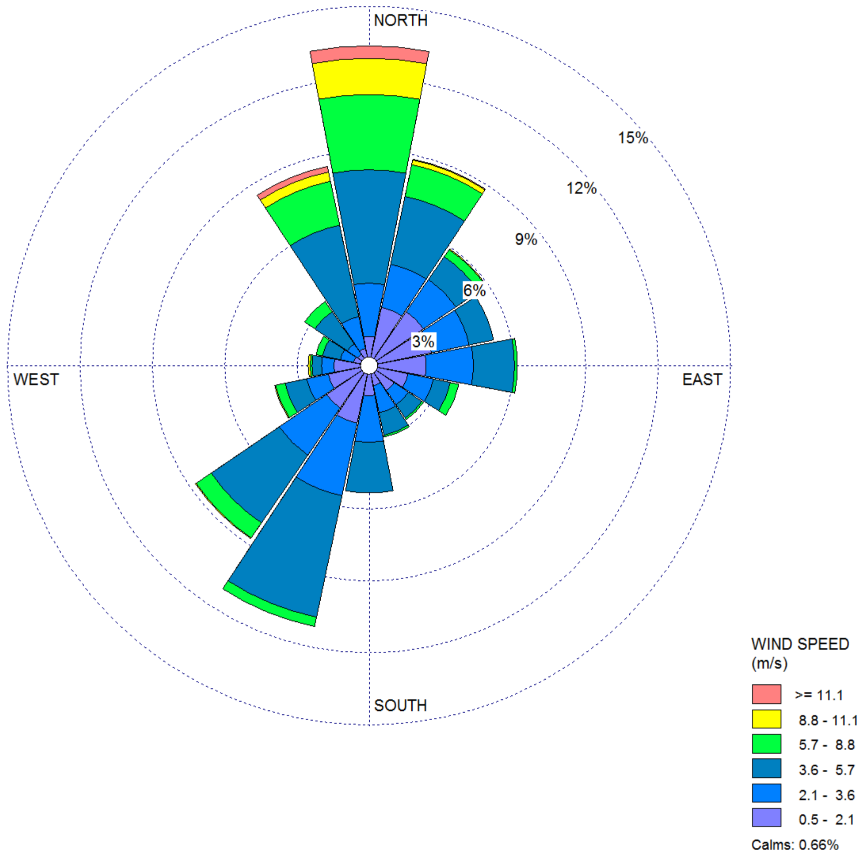


Winter

Figure 2-4: Seasonal wind roses (autumn and winter) for the Jan 2011 – Dec 2013 monitoring period.

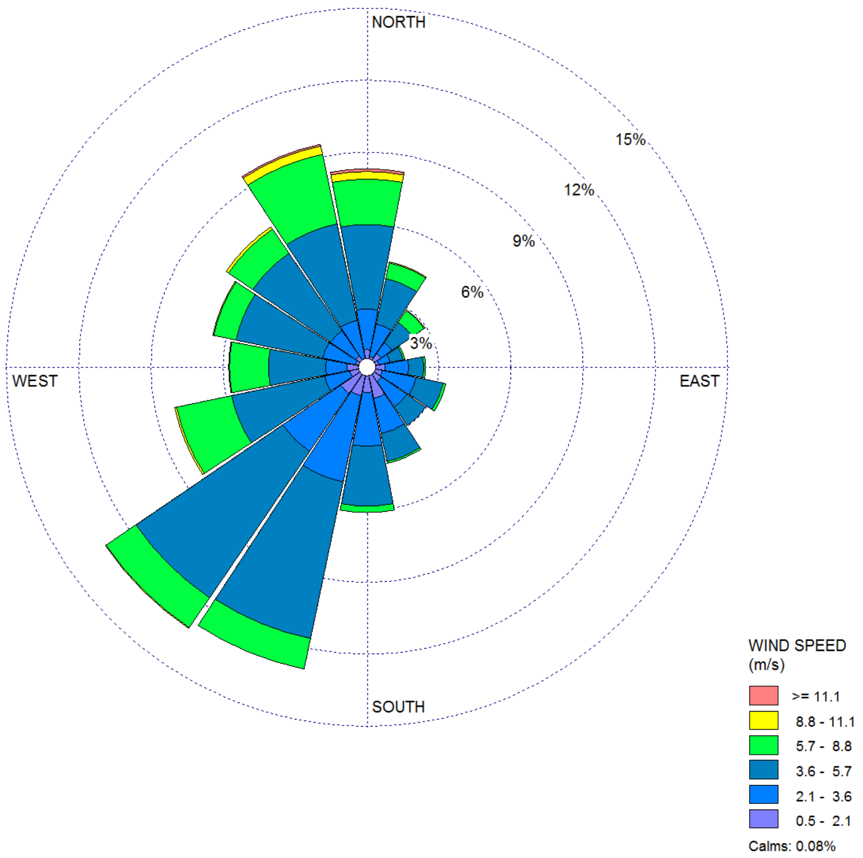


00:00 -06:00

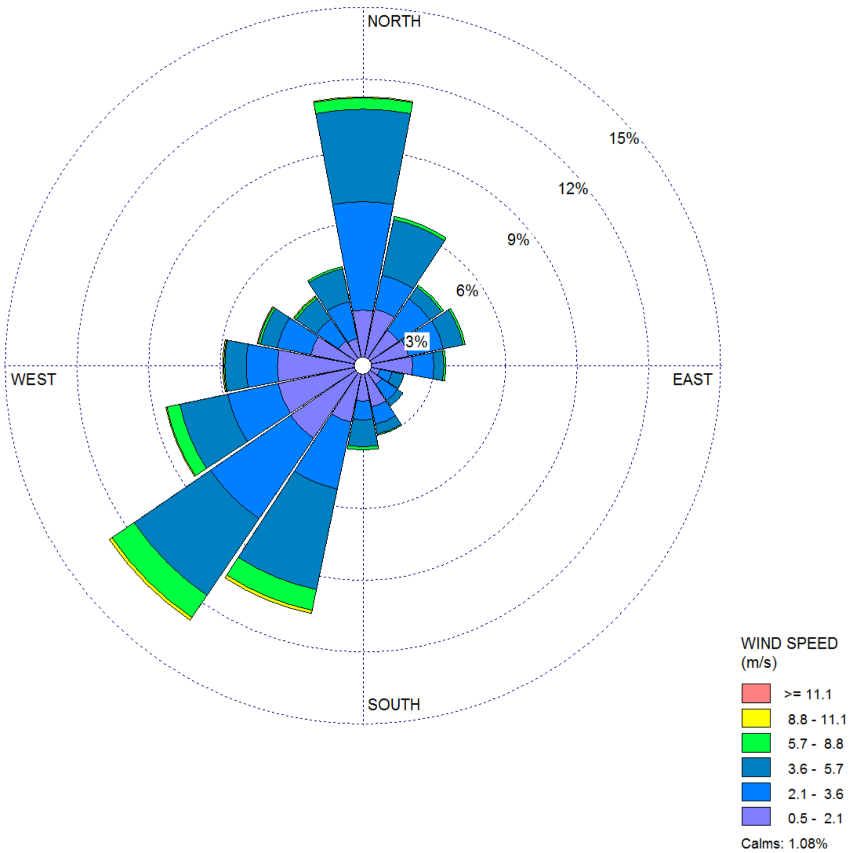


06:00 – 12:00

Figure 2-5: Diurnal wind roses (00:00 – 06:00) for the Jan 2011 – Dec 2013 monitoring period.



12:00 -18:00



18:00-24:00

Figure 2-6: Diurnal period wind roses for the Jan 2011 – Dec 2013 monitoring period.

2.1.2 Atmospheric stability

Atmospheric stability is commonly categorised into one of seven stability classes. These are briefly described in Table 2-1 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 a stable layer, with limited vertical mixing, exists. During windy and/or cloudy conditions, the atmosphere is normally neutral. A neutral atmospheric potential neither enhances nor inhibits mechanical turbulences. An unstable atmospheric condition enhances turbulence, whereas a Stable atmospheric condition inhibits mechanical turbulence.

Table 2-1: Atmospheric stability class

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

The site experienced mostly neutral atmospheric conditions (22%) which are characteristic of high winds or cloudy days and nights. 17.3% of the time was attributed to moderately stable wind conditions which are characteristic of low winds, clear skies and cold night time conditions.

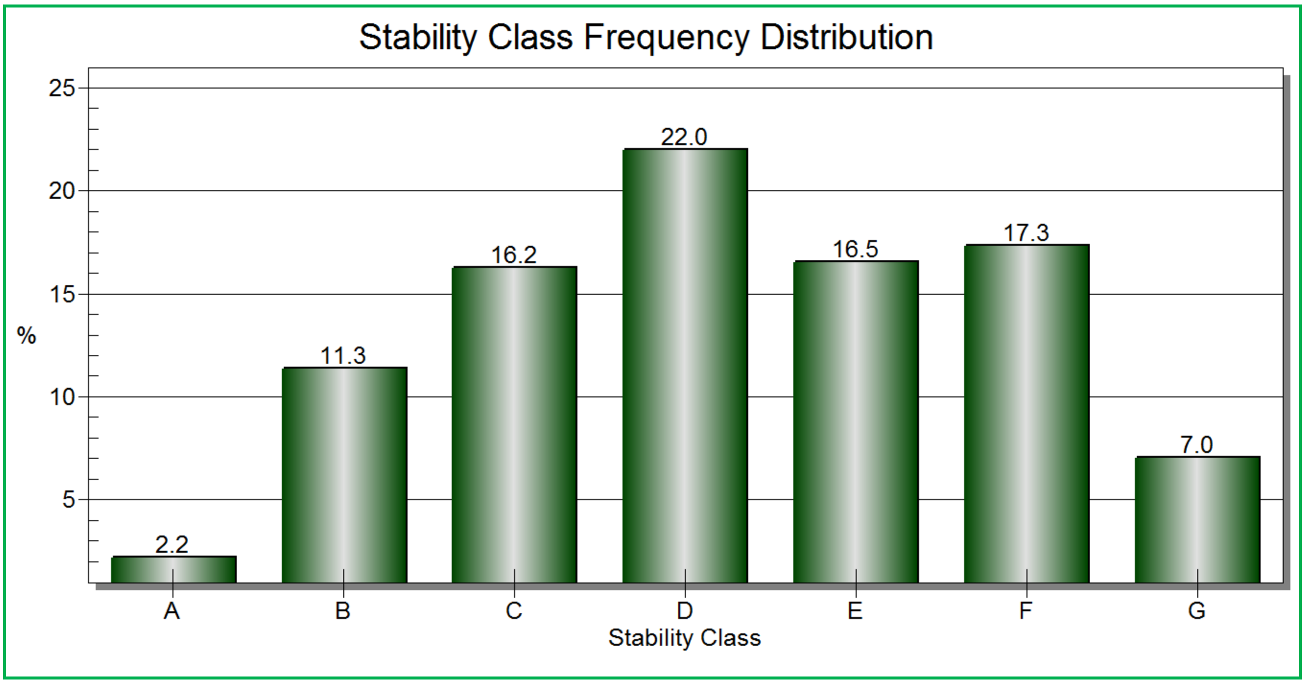


Figure 2-7: Atmospheric stability class.

2.1.3 Temperature and Humidity

Temperature affects the formation, action, and interactions of pollutants in various ways (Kupchella & 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. Temperature also provides an indication of the rate of development and dissipation of the mixing layer as well as determining the effect of plume buoyancy; the larger the temperature difference between the plume and ambient air, the higher the plume is able to rise. Higher plume buoyancy will result in an increased lag time between the pollutant leaving the source, and reaching the ground. This additional time will allow for greater dilution and ultimately a decrease in the pollutant concentrations when reaching ground level.

Table 2-2 below indicates the average temperature profile experienced at the site for the Jan 2011 - Dec 2013 monitoring period. Daily average summer temperatures ranged between 27 – 29 ºC, with a maximum temperature range of 21 - 37 ºC. The average temperature range during the winter months ranged between 11.4 -13.4 ºC.

Table 2-2: Temperature profile for the CSP project from Jan 2011 – Dec 2013

		Temperature	Temperature	Temperature
		Average	Max	Min
		°C	°C	°C
January		29.0	37.0	21.0
February		27.0	35.0	20.0
March		26.0	34.0	18.1
April		20.0	28.0	12.0
May		16.0	25.0	8.4
June		11.4	21.0	4.2
July		11.2	21.0	4.0
August		13.4	23.0	5.0
September		17.2	27.0	8.0
October		21.3	30.0	12.2
November		25.0	34.0	16.0
December		27.0	35.0	19.0
Annual	**Average**	20.3	29.0	12.2
Winter		16.2	25.1	9.0
Summer		24.3	33.0	16.0

2.1.4 Relative Humidity

Humidity is the mass of water vapour per unit volume of natural air. When temperatures are at their highest the humidity is also high, the moisture is trapped inside the droplets of the water vapour. This makes the moisture content of the air high. 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 also dissolve in water to form acids, as well as secondary pollutants within the atmosphere.

Figure 2-8 below illustrates the relative humidity for the CSP project for the Jan 2011 – Dec 2013 monitoring period. Humidity was highest during the winter months with an average of 45.8% and 31.6 % during the summer months.

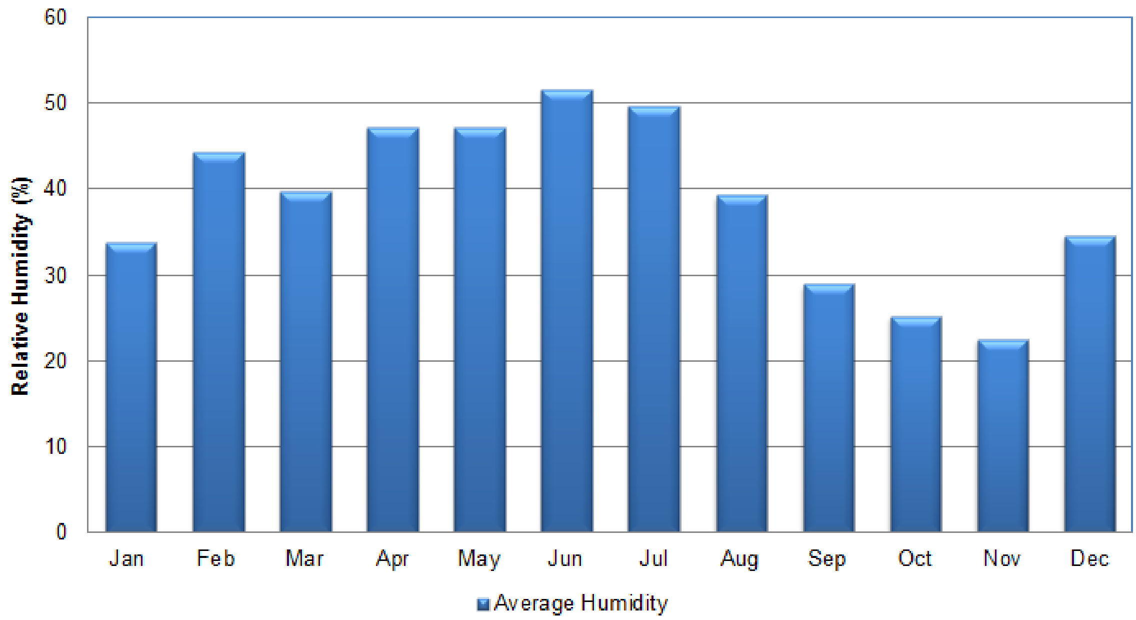


Figure 2-8: Relative humidity for the Jan 2011 – Dec 2013 monitoring period.

2.1.5 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). Summary of the total rainfall profile for the January 2011 – December 2013 monitoring period is illustrated in Figure 2-9 below. The average rainfall observed for the period under review was recorded at 300.2 mm. The highest rainfall was recorded during the summer months (Dec, Jan and Feb) with 152.2 mm, while the lowest rainfall was recorded during the spring months (Sep, Oct and Nov) with 14.6 mm and winter months (May, Jun and Jul) with 25.3 mm.

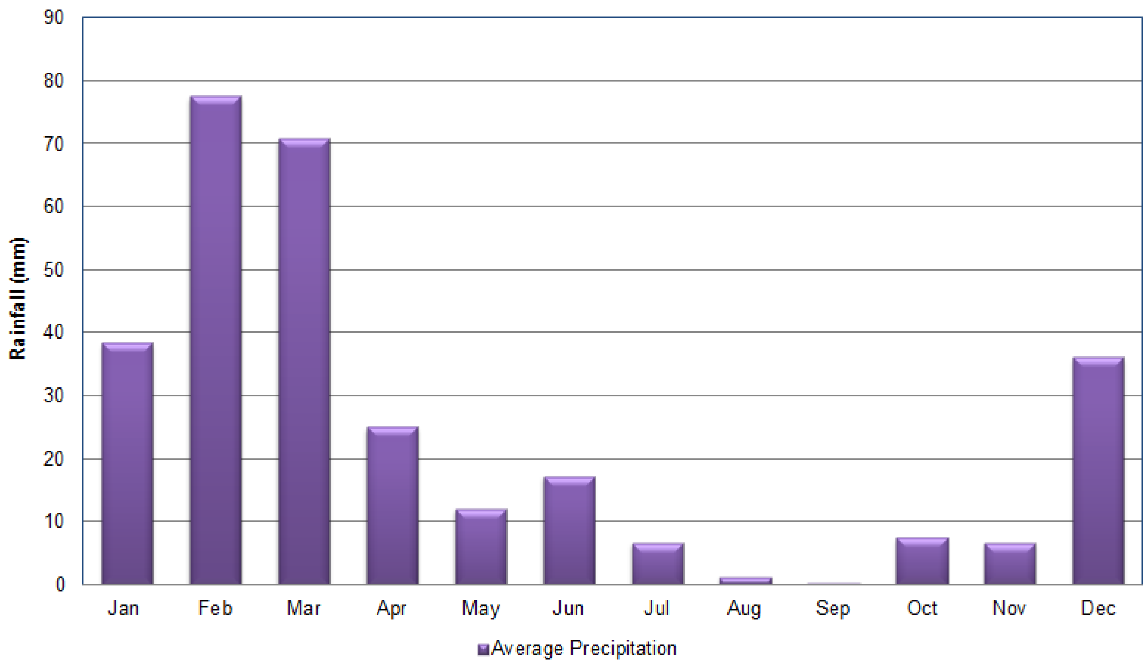


Figure 2-9: Average precipitation for the Jan 2011 – Dec 2013 monitoring period

3 APPLICABLE LEGISLATION

3.1 National Environmental Management: Air Quality Act 39 of 2004

The National Environmental Management: Air Quality Act 39 of 2004 has shifted the approach of air quality management from source-based control to receptor-based control. The main objectives of the Act are to:

- Give effect to everyone's right 'to an environment that is not harmful to their health and well-being'
- Protect the environment by providing reasonable legislative and other measures that (i) prevent pollution and ecological degradation, (ii) promote conservation and (iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development

The Act makes provision for the setting and formulation of national ambient air quality standards for 'substances or mixtures of substances which present a threat to health, well-being or the environment'. More stringent standards can be established at the provincial and local levels.

The control and management of emissions in AQA relates to the listing of activities that are sources of emission and the issuing of emission licences. Listed activities are defined as activities which 'result in atmospheric emissions and are regarded to have a significant detrimental effect on the environment, including human health'. Listed activities have been identified by the minister of the Department of Environmental Affairs and atmospheric emission standards have been established for each of these activities. These listed activities now require an atmospheric emission licence to operate. The issuing of emission licences for Listed Activities is the responsibility of the metropolitan and district municipalities.

In addition, the minister may declare any substance contributing to air pollution as a priority pollutant. Any industries or industrial sectors that emit these priority pollutants will be required to implement a Pollution Prevention Plan. 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 is responsible for the issuing of atmospheric emission licences.

3.2 National Ambient Air Quality Standards

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 guideline values 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.

The Department of Environmental Affairs and Tourism (DEAT) have issued ambient air quality guidelines to support receiving environment management practices. Ambient air quality guidelines are only available for such criteria pollutants which are commonly emitted, such as Particulates, SO_2, Pb, NO_x, benzene and CO. The guidelines specific to the relevant pollutants during this assessment are detailed in the sections below.

3.2.1 Particulate matter

Particulate matter is the collective name for fine solid or liquid particles added to the atmosphere by processes at the earth's surface. Particulate matter includes dust, smoke, soot, pollen and soil particles (Kemp, 1998). Particulate matter has been linked to a range of serious respiratory and cardiovascular health problems. The key effects associated with exposure to ambient particulate matter include: premature mortality, aggravation of respiratory and cardiovascular disease, aggravated asthma, acute respiratory symptoms, chronic bronchitis, decreased lung function, and an increased risk of myocardial infarction (USEPA, 1996).

Particulate matter represents a broad class of chemically and physically diverse substances. Particles can be described by size, formation mechanism, origin, chemical composition, atmospheric behaviour and method of measurement. The concentration of particles in the air varies across space and time, and is related to the source of the particles and the transformations that occur in the atmosphere (USEPA, 1996).

Particulate Matter can be principally characterised as discrete particles spanning several orders of magnitude in size, with inhalable particles falling into the following general size fractions (USEPA, 1996):

- PM10 (generally defined as all particles equal to and less than 10 microns in aerodynamic diameter; particles larger than this are not generally deposited in the lung);
- PM2.5, also known as fine fraction particles (generally defined as those particles with an aerodynamic diameter of 2.5 microns or less)
- PM10-2.5, also known as coarse fraction particles (generally defined as those particles with an aerodynamic diameter greater than 2.5 microns, but equal to or less than a nominal 10 microns); and
- Ultra fine particles generally defined as those less than 0.1 microns.

Fine and coarse particles are distinct in terms of the emission sources, formation processes, chemical composition, atmospheric residence times, transport distances and other parameters. Fine particles are directly emitted from combustion sources and are also formed secondarily from gaseous precursors such as sulphur dioxide, nitrogen oxides, or organic compounds. Fine particles are generally composed of sulphate, nitrate, chloride and ammonium compounds, organic and elemental carbon, and metals.

Table 3-1: Ambient air quality standards and guidelines for particulate matter.

Pollutant	Averaging period (µg/m^3)	Guideline (µg/m^3)	Number of Exceedance Allowed Per Year
PM10	Daily average	120 (1) 75 (2)	4 4
	Annual average	50 (1) 40 (2)	0 0
PM2.5	Daily average	65 (3) 40 (4) 25 (5)	4 4 4
	Annual average	25 (3) 20 (4) 15 (5)	0 0 0

3.2.2 Nuisance Dust

On the 7th of December 2012 the minister of Water and Environmental affairs published the new National Dust Control Regulations. This document now enforces the monitoring of dust fallout from activities that is suspected of contributing significantly to dust fallout in its region. The regulation provides a set standard for dust fallout to comply to, enforces that a baseline should be established to projects that would give rise to increased dust fallout, specifications for dust fallout monitoring and the format of reports if the activity should exceed the thresholds.

If an activity exceeds the standard the entity must submit a dust monitoring report to the air quality officer (local authority), before December 2013 (Section 4, GN1007 of 2012). The entity must develop a dust management plan, within three months after the submission of a dust monitoring report (Section 5, GN1007 of 2012). If the dust fallout is continued to be exceeded, the authority may request that continuous PM_{10} monitoring be conducted at the site.

Table 3-2: Acceptable Dust fallout rates as measured (using ASTM d1739:1970 or equivalent) at and beyond the boundary of the premises where dust originates.

Restriction area	Dustfall rate, D (mg/m²/day, 30-day average)	Comment
Residential	D < 600	Two within a year, not sequential months.
Non residential	600 < D < 1200	Two within a year, not sequential months.

3.2.3 Oxides of Nitrogen

Air quality guidelines and standards issued by most other countries and organisations tend to be given exclusively for NO_2 concentrations as NO_2 is the most important species from a human health point of view. International and South African standards for NO_2 are presented in Table 3-3.

Table 3-3: ambient air quality guidelines and standards for oxides of nitrogen

Averaging Period	South Africa		WHO		EC		Australia	
	µg/m³	ppm	µg/m³	ppm	µg/m³	ppm	µg/m³	Ppm
Annual Ave	40	0.021	40	0.021	40	0.021	57	0.03
Max. 1-hr	200	0.10	200	0.10	200	0.10	240	0.12

NO_2 is an irritating gas that is absorbed into the mucous membrane of the respiratory tract. The most adverse health effect occurs at the junction of the conducting airway and the gas exchange region of the lungs. The upper airways are less affected because NO_2 is not very soluble in aqueous surfaces. Exposure to NO_2 is linked with increased susceptibility to respiratory infection, increased airway resistance in asthmatics and decreased pulmonary function.

Available data from animal toxicology experiments indicate that acute exposure to NO_2 concentrations of less than 1 880 µg/m³ (1 ppm) rarely produces observable effects (WHO 2000). Normal healthy humans, exposed at rest or with light exercise for less than two hours to concentrations above 4 700 µg/m³ (2.5 ppm), experience pronounced decreases in pulmonary function; generally, normal subjects are not affected by concentrations less than 1 880 µg/m³ (1.0 ppm). One study showed that the lung function of subjects with chronic obstructive pulmonary disease is slightly affected by a 3.75-hour exposure to 560 µg/m³ (0.3 ppm) (WHO 2000).

Asthmatics are likely to be the most sensitive subjects, although uncertainties exist in the health database. The lowest concentration causing effects on pulmonary function was reported from two laboratories that exposed mild asthmatics for 30 to 110 minutes to 565 µg/m³ (0.3 ppm) NO_2 during intermittent exercise. However, neither of these laboratories was able to replicate these responses with a larger group of asthmatic subjects. NO_2 increases bronchial reactivity, as measured by the response of normal and asthmatic subjects following exposure to pharmacological bronchoconstrictor agents, even at levels that do not affect pulmonary function directly in the absence of a bronchoconstrictor. Some, but not all, studies show increased responsiveness to bronchoconstrictors at NO_2 levels as low as 376-565 µg/m^3 (0.2 to 0.3 ppm); in other studies, higher levels had no such effect. Because the actual mechanisms of effect are not fully defined and NO_2 studies with allergen challenges showed no effects at the lowest concentration tested (188 µg/m^3; 0.1 ppm), full evaluation of the health consequences of the increased responsiveness to bronchoconstrictors is not yet possible.

Studies with animals have clearly shown that several weeks to months of exposure to NO_2 concentrations of less than 1 880 µg/ m^3 (1ppm) causes a range of effects, primarily in the lung, but also in other organs such as the spleen and liver, and in blood. Both reversible and irreversible lung effects have been observed. Structural changes range from a change in cell type in the tracheobronchial and pulmonary regions (at a lowest reported level of 640 µg/m^3), to emphysema-like effects. Biochemical changes often reflect cellular alterations, with the lowest effective NO_2 concentrations in several studies ranging from 380-750µg/m^3. NO_2 levels of about 940 µg/m^3 (0.5ppm) also increase susceptibility to bacterial and viral infection of the lung. Children of between 5-12 years old are estimated to have a 20% increased risk for respiratory symptoms and disease for each increase of 28 µg/m^3 NO_2 (2-week average), where the weekly average concentrations are in the range of 15-128 µg/m^3 or possibly higher. However, the observed effects cannot clearly be attributed to either the repeated short-term high-level peak, or to long-term exposures in the range of the stated weekly averages (or possibly both). The results of outdoor studies consistently indicate that children with long-term ambient NO_2 exposures exhibit increased respiratory symptoms that are of longer duration, and show a decrease in lung function.

3.2.4 Sulphur dioxide

SO_2 is an irritant that is absorbed in the nose and aqueous surfaces of the upper respiratory tract, and is associated with reduced lung function and increased risk of mortality and morbidity. Adverse health effects of SO_2 include coughing, phlegm, chest discomfort and bronchitis.

Short-period exposures (less than 24 hours)

Most information on the acute effects of SO_2 comes from controlled chamber experiments on volunteers exposed to SO_2 for periods ranging from a few minutes up to one hour (WHO 2000). Acute responses occur within the first few minutes after commencement of inhalation. Further exposure does not increase effects. Effects include reductions in the mean forced expiratory volume over one second (FEV_1), increases in specific airway resistance, and symptoms such as wheezing or shortness of breath. These effects are enhanced by exercise that increases the volume of air inspired, as it allows SO_2 to penetrate further into the respiratory tract. A wide range of sensitivity has been demonstrated, both among normal subjects and among those with asthma. People with asthma are the most sensitive group in the community. Continuous exposure-response relationships, without any clearly defined threshold, are evident.

Sub-chronic exposure over a 24-hour period

Information on the effects of exposure averaged over a 24-hour period is derived mainly from epidemiological studies in which the effects of SO_2, suspended particulate matter and other associated pollutants are considered. Exacerbation of symptoms among panels of selected sensitive patients seems to arise in a consistent manner when the concentration of SO_2 exceeds 250 µg/m^3 in the presence of suspended particulate matter. Several more recent studies in Europe have involved mixed industrial and vehicular emissions now common in ambient air. At low levels of exposure (mean annual levels below 50 µg/m^3; daily levels usually not exceeding 125 µg/m^3) effects on mortality (total, cardiovascular and respiratory) and on hospital emergency admissions for total respiratory causes and chronic obstructive pulmonary disease (COPD), have been consistently demonstrated. These results have been shown, in some instances, to persist when black smoke and suspended particulate matter levels were controlled for, while in others no attempts have been made to separate the pollutant effects. In these studies no obvious threshold levels for SO_2 has been identified.

Long-term exposure

Earlier assessments, using data from the coal-burning era in Europe judged the lowest-observed-adverse-effect level of SO_2 to be at an annual average of 100 µg/m^3, when present with suspended particulate matter. More recent studies related to industrial sources of SO_2, or to the changed urban mixture of air pollutants, have shown adverse effects below this level. There is, however, some difficulty in finding this value.

Based upon controlled studies with asthmatics exposed to SO_2 for short periods, the WHO (WHO 2000) recommends that a value of 500 µg/m^3 (0.175 ppm) should not be exceeded over averaging periods of 10 minutes. Because exposure to sharp peaks depends on the nature of local sources, no single factor can be applied to estimate corresponding guideline values over longer periods, such as an hour. Day-to-day changes in mortality, morbidity, or lung function related to 24-hour average concentrations of SO_2 are necessarily based on epidemiological studies, in which people are in general exposed to a mixture of pollutants; and guideline values for SO_2 have previously been linked with corresponding values for suspended particulate matter. This approach led to a previous guideline 24-hour average value of 125 µg/m^3 (0.04 ppm) for SO_2, after applying an uncertainty factor of two to the lowest-observed-adverse-effect level. In more recent studies, adverse effects with significant public health importance have been observed at much lower levels of exposure. However, there is still a large uncertainty with this and hence no concrete basis for numerical changes of the 1987-guideline values for SO_2.

Table 3-4: Ambient Air quality Standards and guidelines for Sulphur dioxide

Origin	Annual Average Maximum (µg/m^3)	24-Hour Maximum (µg/m^3)	1-Hour Maximum (µg/m^3)	<1-Hour Maximum (µg/m^3)
RSA	50	125	350	500 (10 min average)
WHO	50 10-30	125	-	500 (10 min average)
EC	20	125	350	
UK	20	125	350	266 (15 min mean)
World Bank	50	125	-	-
US-EPA	80	365	-	-
Australia	53	209	520	-

3.2.5 Listed Activities

The Air Quality Act requires all persons undertaking listed activities in terms of Section 21 of the Act to obtain an Atmospheric Emission Licence. The Listed Activities and Associated Minimum Emission Standards was issued by the Department of Environmental Affairs on 31 March 2010 (Government Gazette No 33064).

The following listed activties which have the potential to be triggered are listed below:

Table 3-5: Category 1. Subcategory 1.2: Liquid fuel combustion installations (excluding any material that is regarded as waste in terms of the Waste Act, 2008).

Description	Liquid fuels combustion installations used primarily for steam raising or electricity generation		
Application	All installations with design capacity equal to or greater than 50 MW heat input per unit, based on the lower calorific value of the fuel used.		
Substance or mixture of substances		Plant status	Mg/Nm³ under normal conditions of 3% O_2, 273 kelvin and 101.3 kPa.
Common name	Chemical symbol		
Particulate matter	N/A	New	50
		Existing	75
Sulphur dioxide	SO_2	New	500
		Existing	3500
Oxides of nitrogen	NO_x expressed as NO_2	New	250
		Existing	1100

a) The following special arrangements shall apply –

I. Reference conditions for gas turbine shall be 15% O_2, 273K and 101.3kPa

II. Continuous emission monitoring of PM, SO_2 and NO_x is required.

Table 3-6: Subcategory 1.4: Gas combustion installations (excluding any material that is regarded as waste in terms of the Waste Act, 2008).

Description	Gas combustion (including gas turbines burning natural gas) used primarily for steam raising or electricity generation.		
Application	All installations with design capacity equal to or greater than 50 MW heat input per unit, based on the lower calorific value of the fuel used.		
Substance or mixture of substances		Plant status	Mg/Nm³ under normal conditions of 3% O_2, 273 kelvin and 101.3 kPa.
Common name	Chemical symbol		
Particulate matter	N/A	New	10
		Existing	10
Sulphur dioxide	SO_2	New	400
		Existing	500
Oxides of nitrogen	NO_x expressed as NO_2	New	50
		Existing	300

a) The following special arrangements shall apply - Reference conditions for gas turbine shall be 15% O_2, 273K and 101.3kPa

Table 3-7: Subcategory 1.5: Reciprocating engines

Description	Liquid and gas fuel stationary engines used primarily for steam raising or electricity generation.		
Application	All installations with design capacity equal to or greater than 50 MW heat input per unit, based on the lower calorific value of the fuel used.		
Substance or mixture of substances		Plant status	Mg/Nm^3 under normal conditions of 3% O_2, 273 kelvin and 101.3 kPa.
Common name	Chemical symbol		
Particulate matter	N/A	New	50
		Existing	50
Sulphur dioxide	SO_2	New	2000* 400**
		Existing	2000* 400**
Oxides of nitrogen	NO_x expressed as NO_2	New	1170*
		Existing	1170*

*Liquid fuels fired

**Gas fired

a) The following special arrangements shall apply –

I. Existing plants must comply with minimum emissions standards for existing plant as contained in Part 3 within 5 years of the date of publication of this notice.

II. Existing plant must comply with minimum emission standards for new plant as contained in Part 3 within 10 years of the date of publication of this notice.

The following listed activities will be refined once engineering designs have been finalised.

3.3 Sensitive receptors

A sensitive receptor for the purpose of this report is identified as a place or activity which could involuntarily be exposed to air emissions generated from the proposed operations. Based on this definition the residential, educational and recreational land uses in the area are considered to be sensitive receptors. For this study, the position of houses/dwellings on the farms was identified through use of Google Earth.

The area surrounding the proposed project is boarded by neighbouring farms. Sensitive receptors identified through Google Earth are presented in the Table 3-8 below. Other sensitive receptors within the area would be local fauna and flora. It has also been identified that dust settling on leaves on plants can result in damage to plants and inhalation of dust may result in sickness and associated lung disease for wildlife and humans which will be present in the vicinity of the site, especially during construction.

Table 3-8: Identified sensitive receptor surrounding the proposed site

Sensitive receptor	Distance from site	Direction from site
Groblershoop	~ 19 km	SW
Gariep	~ 15 km	NW
Salskop	~ 11 km	W
Grootdrink	~ 9 km	NW
Upington	~ 70 km	NW

3.4 Existing sources of pollution

Based on satellite imagery the following surrounding sources of air pollution have been identified in the area:

- Domestic fuel burning
- Agricultural

A qualitative discussion of each identified source is provided in the subsection below. The aim of this section is to highlight the potential contribution of surrounding sources to the overall ambient air quality within the area.

3.4.1 Domestic fuel burning

It is anticipated that low income households and communities within the area are likely to combust domestic fuels for space heating and/or cooking purposes. Typical domestic fuels used are wood, paraffin and coal as the economic benefits are advantageous, however the environmental and health effects can be detrimental. Emissions released from biomass and coal combustion emit a large number of pollutants and known health hazards including criteria pollutants such as Particulate matter (PM), Carbon monoxide (CO), Nitrogen dioxide (NO_2), Sulphur dioxide (SO_2) as well as formaldehyde, Polycyclic organic matter and carcinogenic compounds such as benzo (a) pyrene.

The combustion of coal in particular results in an incomplete process that releases CO, methane (CH_4) and NO_2. The implications for indoor pollution as a result is a growing concern and has been indicated in varying degrees of evidence as a causal agent of acute respiratory infections, chronic pulmonary diseases and lung cancer in developing countries (Barnes et al, 2009).

3.4.2 Agricultural

Agricultural activity can be considered a significant contributor to particulate emissions, although tilling, harvesting and other activities associated with field preparation are seasonally based. The main focus internationally with respect to emissions generated due to agricultural activity is related to animal husbandry, with special reference to malodours generated as a result of the feeding and cleaning of animals. The land use along the Orange River is predominantly agricultural crops such as grapes and raisins which are grown in the flood plains of the Orange River. Sheep and cattle farming are also practiced in the area.

The activity associated with irrigation farming includes the application of pesticides, herbicides, weed control, fertilizers, harvesting activities, phosphate and nitrogen addition.

Little information is available with respect to the emissions generated due to the growing of crops. The activities responsible for the release of particulates and gases to atmosphere would however include:

- Particulate emissions generated due to wind erosion from exposed areas;
- Particulate emissions generated due to the mechanical action of equipment used for tilling and harvesting operations;
- Vehicle entrained dust on paved and unpaved road surfaces;
- Gaseous and particulate emissions due to fertilizer treatment and Gaseous emissions due to the application of herbicides and pesticides

4 DESCRIPTION OF POTENTIAL IMPACTS ASSOCIATED WITH ACTIVITY

The scoping impact assessment phase of the investigation assesses the potential impact that the construction and operational phase of the proposed project could have on the surrounding environment.

This Section of the report outlines the potential impacts with the construction and operation of the proposed project. To clearly detail the potential impacts in ambient ground level concentrations, only operational emissions will be evaluated during the impact assessment phase of the EIA. The construction and decommissioning phases of the operation can only be qualitatively addressed due to the variability and unpredictable nature of the construction operations on site, and initial details are provided in the subsections to follow.

4.1 Construction Impacts

Construction is a source of dust emission which has a temporary impact on the local air quality. Infrastructure and road construction are the two types of construction activity with high emission potentials. The emissions associated during the construction of a building or road can be associated with land clearing, drilling and blasting, ground excavation and depending on the level of activity, the specific operation and the prevailing meteorological conditions. It has been noted that large quantities of the emissions is generated due to the traffic movement of equipment across temporary roads and around the construction site (USEPA, 1996).

The temporary nature of construction activities is what distinguishes it from other fugitive sources present within the locality. Emissions from construction activities are expected to have a definitive start and end period and will vary depending on the various construction phases. In contrast to other fugitive sources, here the emissions occur in a steady state or follow a discernible pattern. The quantity of dust emissions from construction activities is proportional to the area of land under construction (USEPA, 1996).

The impact on air quality and air pollution of fugitive dust is dependent on the quantity and drift potential of the dust particles (USEPA, 1996). Large particles settle out near the source causing a local nuisance problem. Fine particles can be dispersed over much greater distances. Fugitive dust may have significant adverse impacts such as reduced visibility, soiling of buildings and materials, reduced growth and production in vegetation and may affect sensitive areas and aesthetics. Fugitive dust can also adversely affect human health.

The following components of the environment which may be impacted upon during the project construction phase:

- The ambient air quality
- Local residents, farms and neighbouring communities
- The surrounding environment and possible the fauna and flora.

Because construction is of a temporary nature, it is recommended that mitigation/ control measures be put in place to limit the impacts on the local air quality. Wet suppression and wind speed reduction are common methods used to control open dust sources at construction sites.

4.2 Operational Impacts

The EIA impact assessment modelling will aim to deal with the potential air quality impacts which could result due to the construction and operation of the concentrated solar power plant on the Sandraai Farm. The details regarding the source characteristics will be obtained from site layout plans and process specific information provided and a questionnaire filled in by the client. Such information relates to the type of activities and fuels utilised on site.

Once all site layout plans and final geotechnical works are complete, site specific information should then be sufficient for dispersion modelling simulations and will be included in the EIA report. More information pertaining to the operational impacts will be available at the EIA stage.

4.3 Decommissioning impacts

The decommissioning phase is associated with activities related to the demolition of infrastructure and the rehabilitation of disturbed areas. The total rehabilitation will ensure that the total area will be a free draining covered with topsoil and grassed. 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;
- Topsoil replaced using topsoil recovered from stockpiles; and
- Land and permanent waste piles prepared for re-vegetation.

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 re-vegetation – ploughing and addition of fertiliser, compost etc.

Exposed soil is often prone to erosion by water. The erodability 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). Re-vegetation 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.

4.4 Plan of Study

The proposed methodology which will be followed during the air quality impact assessment phase is provided as follows:

- Determine the atmospheric dispersion potential for the area being assessed.
- In order to assess the possible cumulative air quality impacts, monitored ambient and meteorological data will be sourced for the area under investigation.
- If there is no ambient monitored data available, a qualitative assessment will be undertaken which will evaluate the possible impacts of other polluting sources within the area.
- Information gaps in the data provided will be identified.

An assessment of the operational phases of the proposed project will be undertaken by evaluating (where possible) both fugitive and point source emissions.

Emission rates and source characteristics obtained from the client will be input into the AerMod View dispersion model to predict the off-site air quality impacts. The model used in the estimation of impacts arising from the proposed activities has an uncertainty which is equal to 2, this it is possible for the results to be over predicting by double or under predicting by half. It is therefore recommended that monitoring to be carried out at the proposed mine during operations to confirm the modelled results and to ensure legal standards are maintained.

An assessment of compliance will be conducted using available health risk screening levels obtained for the pollutants identified. Comparison will be made to both locally and internationally available health risk levels for these pollutants.

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