SPECIALIST ASSESSMENT

AIR QUALITY BASELINE ASSESSMENT FOR SYNCHROPLEX FARM AREACHAP 426 PROSPECTING OPERATION, NORTHERN CAPE – UPINGTON.

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ENVASS

ENVIRONMENTAL ASSURANCE (Pty)Ltd

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DISCLAIMER

DECLARATION OF OBJECTIVENESS-

I, **Anton Botha,** in my capacity as a specialist consultant, hereby declare that I: -

- Act as an independent consultant;
- Do not have any financial interest in the undertaking of this project, other than remuneration for the work performed in terms of the National Environmental Management Act 107 of 1998;
- Have and will not have vested interest in the proposed and/or existing activity nor will I engage myself in any conflicting interest associated with this project;
- I undertake to disclose and provide to the competent authority any material or information at my disposal regarding this project as required in terms of National Environmental Management Act 107 of 1998;
- Based on the information provided to me by the client and in addition to information obtained during the course of this study, I have presented the results and conclusion with regard to this project to the best of my professional ability;
- I reserve the right to modify aspects pertaining to this study should additional information become available through ongoing research and further work on this field;
- I undertake to have my work peer reviewed on a regular basis by a competent specialist in the field of study;
- I am duly qualified and experienced to undertake the work at hand;
- I am bound by and committed to the professional and ethical Code of Conduct of the SACNASP.

Anton Botha (Environmental Consultant)

Environmental Consultant	Relevant expertise
Anton Botha	Has completed a B.Sc. in Environmental Sciences, followed by a B.Sc. (Hons) and M.Sc. specialising in Hydrogeology and Hydrology. Anton has comprehensive experience and knowledge on compliance monitoring, project management and specialist reporting. As an environmental consultant, Anton has provided several environmental monitoring assessments, specialist input services, mine closure quantum's and environmental audits.

EXECUTIVE SUMMARY

This document has been prepared by Environmental Assurance (Pty) Ltd [ENVASS] as an independent environmental consultancy firm as appointed by Sychroplex, to assess the ambient air quality towards the provision of a baseline assessment for the proposed prospecting operations on Farm 426 Areachap – Upington, Northern Cape Province. This report is based on results obtained during a site investigation and assessment conducted during April 2019.

The scope of the assessment focussed on the current ambient baseline conditions of the study area and the possibility of the proposed development to have an impact on the air quality. The results obtained as measured in the baseline assessment was used to report on the ambient air quality. The purpose of the assessment is therefore to determine the current air quality in the immediate vicinity of the proposed prospecting area, the 119 hectares prospecting boundary and the overall Areachap 426 farm extent boundary, in addition to provide insight into the possible impact of the proposed development. A once-off site visit was conducted to measure for specific parameters relating to baseline conditions of the study area. Results were obtained and assessed in terms of current compliance to ambient air quality guidelines and an indication of the possible impacts was determined.

Based on all relevant boundaries (core prospecting facility, 119 ha prospecting boundary and Areachap farm 426 extent), the results presented ideal to moderate air quality in terms of the parameters monitored. It is estimated that construction and prospecting of the bulk-sampling activities of the proposed development will contribute to the total suspended load in the atmosphere however it is anticipated that the load increase and impact will be locals within the core operational area. Several mitigation measures (Table 8 and Table 9) are provided within the report in order to ensure reduction of the total suspended loads and limit significant impacts. The air quality measured is in a relatively good condition, while volatile organic compounds were measured at three monitoring points (AQ 1, AQ 2 and AQ 3) which could be attributed to a range of variables.

An estimation of the impact distance is difficult to determine in terms of the baseline assessment values and thus in order to accurately calculate the fall out distance; investigation in terms of a full air quality impact assessment and dispersion model is proposed.

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GLOSSARY

A list of commonly used terms and acronyms.

ACRONYMS	
ASTM	American Society for Testing and Materials
CO	Carbon Monoxide
CO_2	Carbon Dioxide
ENVASS	Environmental Assurance (Pty) Ltd
NEMA	National Environmental Management Act: Act 109 of 1998.
NEM:AQA	National Environmental Management: Air Quality Act 39 of 2004
PM_{10}	Particulate Matter of less than 10 microns in diameter
SANS	South African National Standards
VOC	Volatile Organic Carbon
MEASUREMENT UNITS	
Mg/L	Milligram per litre
$mg/m^2/day$	Milligram per square meter per day
PPM	Parts per million
$\mu g/m^3$	Microgram per cubic meter
DEFINITIONS	
Ambient air	Outdoor air in the troposphere, excluding air regulated by the relevant national legislation, where air quality is determined in accordance with this standard.
ASTM D1739	Standard test method for the collection measurement of dust fall (settleable particulate matter).
Average period	Period of time over which the average value is determined.
Dust fallout monitoring programme	Means monitoring of gravimetric dust fallout on a continuous basis.
Monthly basis	Period of 30 days (±2 day) as specified by ASTM D1739.
National Dust Control Regulations	Means the National Dust Control regulations, 2013, as published in the Government Gazette (No. 36974) of 1 November 2013 in terms of the National Environmental Management: Air Quality Act 39 of 2004.
Non-residential area	Means any area not classified for residential use as per local town planning scheme.
Residential area	Means any area classified for residential use in terms of the local town planning scheme.
SANS1929: 2011	South African National Standards, Ambient Air Quality – limits for common pollution.

1 INTRODUCTION AND BACKGROUND

1.1 SITE AND PROJECT BACKGROUND

Environmental Assurance (Pty) Ltd (ENVASS), as independent environmental consultants, was appointed by Synchroplex, to assess the baseline air quality for the proposed prospecting activity on Farm 426 Areachap – Upington, Northern Cape Province (refer to Figure 1 and Table 1). This document reports on results and outlines findings and conclusions.

Synchroplex (Pty) Ltd has been granted a prospecting right for copper, zinc, sulphur and iron on Farm Areachap 426, however the right has expired in 2016 and thus a renewal application has been lodged, including an application of a Section 102 for bulk sampling. The farm is located approximately 26 km north west of Upington, Northern Cape Province, within the Gordonia District Municipality and extents to 1 9653.0822 hectares. Access to the site is gained on an unnamed gravel road from the R360 tarred road. The Upington International Airport is situated 25 km southeast of the farm, with the major water resource being the Orange river within the area situated 30 km southeast of the site.

An air quality baseline assessment is required in order to assess baseline conditions and possible impacts associated with the activities. Baseline readings were taken during a site visit in April 2019 for site establishment and sampling.

Table 1: Minerals Prospecting

Item	Detail
Type of Mineral(s)	Copper
Type of minerals continued	Zinc
	Sulphur
	Silver
	Iron
Locality (Direction and distance from nearest town)	28 km North West of Upington within the Gordonia District
Extent of area required for prospecting	19 000 Hectares
Geological formation	Upper oxide zone and lower sulphides ore deposit

This report is structured to include the following:

- Legislative requirements;
- Purpose / Objective of the study;
- Scope of Works / terms of reference;
- Description of methodologies utilised;
- Limitations and assumptions;
- Results from the baseline assessment; and
- Summary of findings and recommendations made.

1.2 EXISTING AND FUTURE SOURCES OF AIR POLLUTION

Historical diggings are present in the area, while prospecting is not active at the site and the only form of air pollution present is based on minimal residential traffic on the associated dirt roads. Future sources of air pollution include planned infrastructure and equipment consisting of:

- Front End loader;
- Excavator;
- Bulldozer:
- Dump Truck (ADT);
- Crushing Plant;
- R&D Pilot Plant;
- Hoist and Winder; and
- Shaft Equipment.

1.3 LAND USE

The area is currently semi-developed with agricultural activities (mainly livestock and game farming), natural areas, and residential housing (farm holdings) in the area. The study area is minimally impacted on with good vegetation cover in the area. The predominant land uses identified on the day of the assessment for the study area include *inter alia*:

- De-centralised housing (small holdings);
- Livestock and game farming in a number of directions;
- Main roads and routes of the study area include:
  - The Servitude road southeast of the study area;
  - The R360 main road to the east of the study area;

- The N10 Highway to the of the south of study area;
- Informal internal routes on the site.

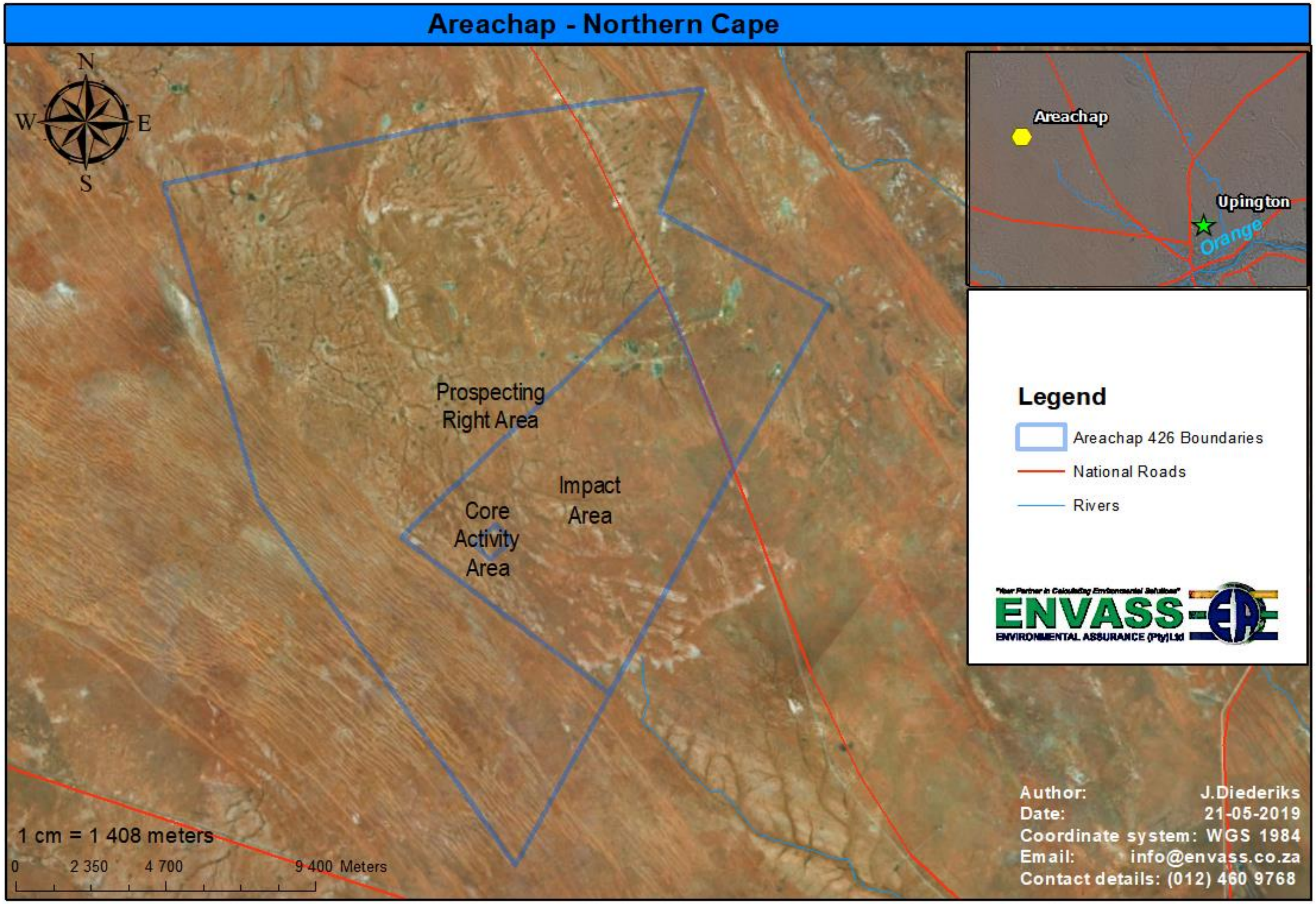

Figure 1: Areachap 426 Boundary Map

2 LEGISLATIVE CONTEXT AND REFERENCES

Section 28 of the National Environmental Management Act (NEMA, Act 107 of 1998) places a duty of care on any person causing, has caused or may cause significant pollution or degradation of the environment to take reasonable measures to prevent such pollution or degradation from occurring, continuing, or, insofar as such harm to the environment is authorised by law or cannot be reasonably avoided or stopped and rectify such pollution of the environment.

The measures required in terms of subsection (1) may include measures to:

- Investigate, assesses and evaluate the impact on the environment,
- Inform and educate employees on the environmental risk of their work and the manner in which tasks must be performed in order to avoid causing significant pollution or degradation of the environment;
- Cease, modify or control any activity or processes causing pollution or degradation;
- Contain or prevent the movement of pollutants or the cause of degradation;
- Eliminate any source of the pollution or degradation; or
- Remedy the effects of pollution or degradation.

The National Environmental Management: Air Quality Act (Act no. 39 of 2004) (AQA) was developed to give effect to NEMA in order to update air quality legislation to comply with general environmental policies and to ensure that the legislation is in line with local and international standards on air quality and air quality management practices. The main objectives of the act are to:

- Enhance and protect air quality;
- Provide reasonable measures and steps to prevent pollution or environmental degradation; and
- To secure sustainable environmental development in conjunction with economic and social development.

In terms of the AQA certain activities and industries have the responsibility to:

- Comply with any relevant standards or bylaws;
- Comply with relevant emission standards;
- Comply with the Minister's requirement for the implementation of a pollution prevention plan in respect of a substance declared as a priority air pollutant;
- Comply with an Air Quality Official's legal request for impact reports;
- Taking reasonable steps to prevent the emission of any offensive odour caused by any activity on their premises.

Guidelines provide a basis for protecting public health from adverse effects of air pollution and for eliminating, or reducing to a minimum, those contaminants of air that are known or likely to be hazardous to human health and well-being (WHO, 2000). The

South African Bureau of Standards (SABS), in collaboration with DEA, established ambient air quality standards for criteria pollutants. The National Ambient Air Quality Standards (Republic of South Africa, 2009a and 2012) provide standards for ambient air quality in terms of criteria pollutants and permitted frequency of exceedances.

3 PURPOSE AND SCOPE

The purpose of this assessment is to determine the baseline ambient air quality of the proposed development area. The baseline air quality assessment will measure the ambient air quality to establish dust and other emissions being generated by the existing and proposed activities to become a nuisance to the surrounding land users and the receiving environment. If it is found that the possibility exists for emissions to pose a problem, a recommendation will be made as to prevent and mitigate the possible effects. This will be done in order to prevent disturbance to the receiving environment and enable the mitigation and control of emissions before the activities start. This report also aims to give effect to the requirements and legislation as promulgated in South Africa. Please refer to Section 2 for detailed legislative requirements for the study. Key aspects for the purpose of this document is to:

- Describe baseline air quality conditions and how it could be affected;
- Raise relevant air quality concerns of the proposed project;
- Identify the most sensitive receptors in terms of air quality impact;
- Define the basis for assessing the impact and determining the significance of the impact; and
- To recommend, based on the conditions, mitigation measures.

The scope includes the assessment of the immediate prospecting facility, the 119-hectare prospecting boundary and the overall Farm Areachap 426 extent. This includes active indicative sampling with specialised equipment.

4 METHODOLOGY

4.1 SITE ESTABLISHMENT

An initial desktop site assessment was conducted to determine suitable locations regarding the air quality baseline assessment. The result of the desktop study was the identification of areas or activities which could possibly contribute to the deterioration of the ambient air quality of the area, as well as the baseline condition of the overall farm extent.

Site establishment (and subsequent field work) occurred on the 16^{th} of April 2019 for the proposed development. The site establishment was conducted to undertake the active indicative sampling. Sampling occurred as per the scope of work at the sampling points (twenty-two in total) as indicated in Figure 2 & 3. The site establishment was conducted to measure the ambient air quality actively for at least 5 minutes at each sampling location during normal conditions (no extraordinary activities must occur as the samples would then not be representative of baseline ambient air quality). Sensitive receptors were identified during the assessment which included the residential area of both the land owner and workforce (employees).

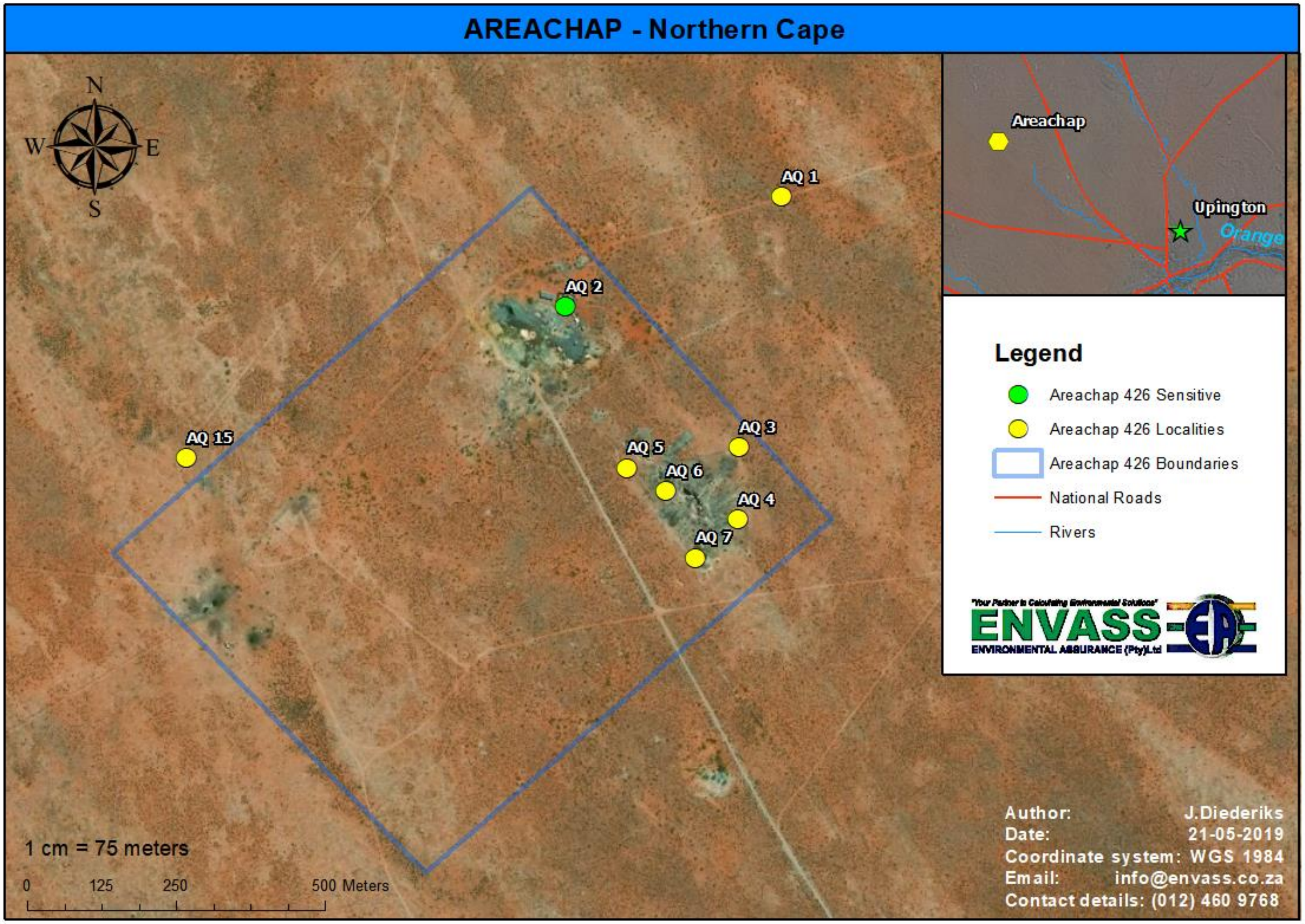

Figure 2: Areachap 426 Core Boundary Monitoring Localities

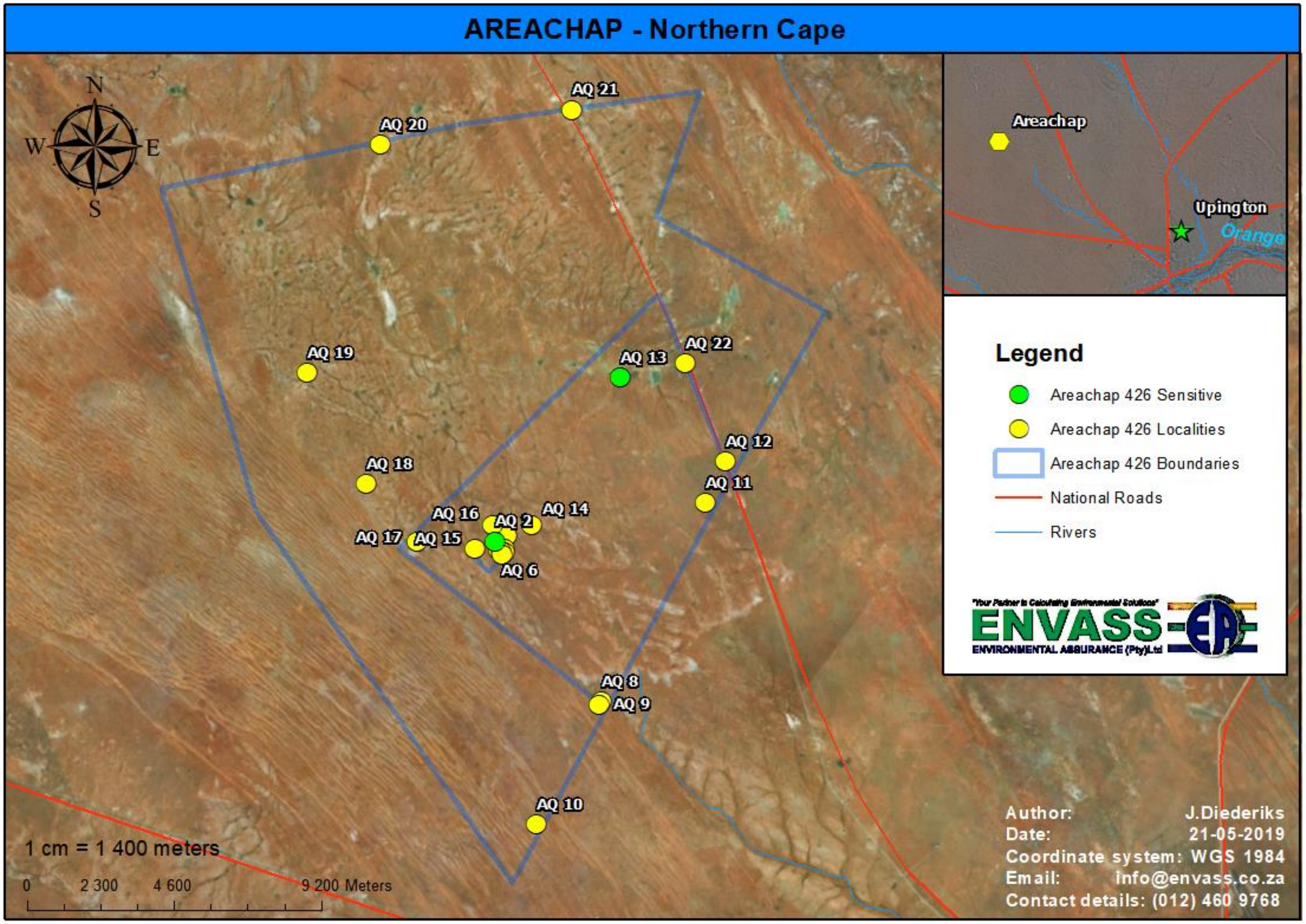

Figure 3: Areachap 426 Impact Boundary and Mining Right Monitoring Localities

4.2 ACTIVE INDICATIVE SAMPLING

Active indicative sampling was carried out with an apparatus named the "Quest Technologies EVM-7 environmental monitoring instrument" (Figure 4). This instrument measures Particle Matter 10µm (PM_{10} in µg/m^3), carbon monoxide (CO in ppm), carbon dioxide (CO_2 in ppm) and volatile organic compounds (VOC in ppm). It also measures the physical conditions of the environment (such as relative humidity and temperature).

Figure 4: The Quest Technologies EVM-7 environmental monitoring instrument

Additional details of the apparatus:

- Model: EVM-7
- Key Features: IAQ and Particulate Monitor
- Description: Particulate and air quality monitoring combined in one instrument.

Quest Technologies EVM-7 offers the unique capability to simultaneously measure particulates (mass concentration), volatile organic compounds (VOCs), toxic gas, and carbon dioxide (CO_2), relative humidity, temperature and air velocity;

- Simultaneously Measure Particulate and Gas Concentrations
- Reduces the need for multiple instruments
- Lowers the cost of sampling.
- 90° Light Scattering Photometer
- Mass concentration engine offers real-time measurement of particulates.
- Built in Sampling Pump for Gravimetric Analysis
- Allows user to insert a 25- or 37-mm filter cassette to capture particulates for laboratory testing.
- Dial-in Rotary Impactor
- Twist and click selection of particulate settings: PM2.5, PM4, PM10 or TSP*

For the assessment, the EVM-7 was utilised to monitor Particle Matter 10µm (PM10 in µg/m^3), carbon monoxide (CO in ppm), carbon dioxide (CO_2 in ppm) and volatile organic compounds (VOC in ppm) at all monitoring points.

4.3 AIR QUALITY BASELINE REPORT

The report is compiled by studying the proposed activities, identifying the potential sensitive receptors and by determining the possible impacts the proposed activities will have on the receiving environment. Various data source inputs were required which included (but not limited to) the following:

- The average applicable weather conditions of the greater area;
- Data acquired from direct measurement with the EVM-7 active indicative sampler;
- The site layout and geographical location;
- Similar installations emission testing results;
- List of activities which could possibly generate emissions; and
- Sensitive receptors in the area.

From the above-mentioned data, the areas or activities on the site most prone to pollutant generation can be determined.

5 POLLUTANT OVERVIEW

5.1 CONSTRUCTION PHASE

Construction activities often generate vast quantities of emissions into the atmosphere by various actions during the construction phase. Some of the intense pollutant generating activities include:

- Fencing and security;
- Site and vegetation clearing;
- Soil stripping, earthworks and diggings;
- Storage of waste and construction materials;
- Materials transport;
- Foundations and construction (plants);
- Surfacing; and
- Finishing;

From these activities, exhaust emissions from construction vehicles and equipment will typically include particulates, such as PM10, carbon monoxide (CO), sulphur dioxide (SO_2) and volatile organic compounds (VOCs). Additionally, disturbance of groundcover caused by groundworks and activities will further impact on particulate matter and the generation of this. In the proposed development area and greater footprint, the only activities present consist of residential and agricultural activities.

5.2 OPERATIONAL PHASE

The proposed activities of the development include the typical activities associated with movement of vehicles and generation of particulate matter, as well as vehicle emissions and other activates including trenching, RC Drilling and crushing.

5.3 POLLUTANT OVERVIEW

5.3.1 PARTICULATE MATTER (PM)

Particles can be classified by its aerodynamic properties into coarse particles (gravimetric), PM_{10} (particulate matter with a diameter of less than or equal to 10 microns) and very fine particles such as $PM_{2.5}$ (particulate matter with a diameter of less than or equal to 2.5 microns) (Harrison and van Grieken, 1998). The fine particles may contain aerosols such as sulphates and nitrates (they “cling” to particulate matter), combustion particles and/or recondensed organic and metal vapours. The coarse particles contain earth crust materials and fugitive dust from roads and industries (Fenger, 2002).

In terms of health impacts, particulate air pollution effects are broad, but are predominately associated with effects of the respiratory and cardiovascular systems (WHO, 2000). Particle size is important for health because it controls where in the respiratory system a given particle deposits. Fine particles have been found to be more damaging to human health than coarse particles as larger particles are less respirable in that they do not penetrate deep into the lungs compared to smaller particles (Manahan, 1991).

Larger particles are deposited into the extra thoracic part of the respiratory tract while smaller particles are deposited into the smaller airways leading to the respiratory bronchioles (WHO, 2000). A study by Pope and Burnett (2002) indicated that PM2.5 leads to high plaque deposits in arteries, causing vascular inflammation and atherosclerosis (Kaonga and Kgabi, 2009). As yet, no evidence of a threshold in the relationship between particulate concentrations and adverse human health effects have been determined (Burger and Scorgie, 2001; WHO 2005).

- *Short-term (acute) exposure*

Recent studies suggest that short-term exposure to particulate matter leads to adverse health effects, even at low concentrations of exposure (below 100 µg/m^3). Morbidity effects associated with short-term exposure to particulates include increases in lower respiratory symptoms, medication use and small reductions in lung function.

- *Long-term (or chronic) exposure*

Long-term exposure to low concentrations (~10 µg/m^3) of particulates is associated with mortality and other chronic effects such as increased rates of bronchitis and reduced lung function (WHO, 2000). Those most at risk include the elderly, individuals with pre-existing heart or lung disease, asthmatics and children; with an increased risk associated with an increase in exposure (WHO 2005).

5.3.2 CARBON MONOXIDE (CO)

Carbon monoxide (CO) is one of the most common and widely distributed air pollutants. CO is a tasteless, odourless and colourless gas which has a low solubility in water. In the human body, after reaching the lungs it diffuses rapidly across the alveolar and capillary membranes and binds reversibly with the haem proteins.

Approximately 80 - 90% of CO binds to haemoglobin to form carboxyhaemoglobin which is a specific biomarker of exposure in blood. The affinity of haemoglobin for CO is 200 – 250 times that for oxygen. This causes a reduction in the oxygen-carrying capacity of the blood which leads to hypoxia as the body is starved of oxygen (WHO, 2005).

Anthropogenic emissions of CO originate from the incomplete combustion of carbonaceous materials. The largest proportion of these emissions is produced from exhausts of internal combustion engines, in particular petrol vehicles. Other sources include industrial processes, coal power plants and waste incinerators.

Ambient CO concentrations in urban areas depend on the density of vehicles and are influenced by topography and weather conditions. In the streets, CO concentrations vary according to the distance from the traffic. In general, the concentration is highest at the leeward side of the "street canyon" with a sharp decline in concentration from pavement to rooftop level (Rudolf, 1994).

- *Short and Long-term exposure*

The adverse health effects of CO vary depending on the concentration and time of exposure. Clinical symptoms range from headaches, nausea and vomiting, muscular weakness, and shortness of breath at low concentrations (10 ppm) to loss of consciousness and death after prolonged exposure or after acute exposure to high CO concentrations (>500 ppm). Poisoning may cause both reversible, short-lasting neurological deficits and severe, often delayed, neurological damage. Neurobehavioral effects include impaired co-ordination, tracking, driving ability, vigilance and cognitive ability at COHb levels as low as 1.5 - 8.2% (WHO, 2000).

High risk patients with regards to CO exposure include persons with cardiovascular diseases (especially ischaemic heart disease), pregnant mothers and the foetus and new-born infants. Epidemiological and clinical studies indicate that CO from smoking and environmental or occupational exposures may contribute to cardiovascular mortality (WHO, 2000).

5.3.3 CARBON DIOXIDE (CO_2)

Carbon Dioxide (CO_2) is a greenhouse gas emitted by means of various activities or actions occurring. CO_2 is naturally present in the environment and as part of the carbon cycle (process whereby carbon is circulated in the atmosphere, water bodies, vegetation and animals) is released and captured on a cyclical basis. Activities undertaken by humans often increase the emission of CO_2 which was captured or stored in natural environments (such as fossilised fuels utilised).

The effect of increased levels of the pollutant can lead to adverse environmental impacts. On a local scale, increased CO_2 is unlikely to have a major impact, however when considered on the global scale cumulative impact, it leads to a global increase in temperatures due to the effect of *capturing* and retention of energy in the atmosphere. On a personal, human health related level, the effect of exposure could lead to a reduction in available oxygen for respiration which can lead to suffocation or lack of oxygen impacts.

5.3.4 VOLATILE ORGANIC COMPOUNDS (VOC’s)

Volatile Organic Compounds (VOCs) are organic chemicals that easily vaporise at room temperature and are colourless. VOCs are released from vehicle exhaust gases either as unburned fuels or as combustion products, and are also emitted by the evaporation of solvents and motor fuels. Short-term exposure to VOCs can cause eye and respiratory tract irritation and damage, headaches, dizziness, visual disorders, fatigue, loss of coordination, allergic skin reactions, nausea, and memory impairment, damage the bone marrow and even death. Long-term exposure to high levels of VOCs has been linked to an increase in occurrence of leukaemia. VOCs can also cause damage to the liver, kidneys and central nervous system.

Trace gases and aerosols impact climate through the effect on the radiative balance of the earth. Trace gases such as greenhouse gases absorb and emit infrared radiation which raises the temperature of the earth’s surface causing the enhanced greenhouse effect. Aerosol particles have a direct effect by scattering and absorbing solar radiation and an indirect effect by acting as cloud condensation nuclei.

Atmospheric aerosol particles range from dust and smoke to mists, smogs and haze (IPCC, 2001). Smogs and haze are common in regions where certain geographic features, such as mountains, and weather conditions, such as temperature inversions, contribute to the trapping of air pollutants (Kumar and Mohan, 2002). Smogs and haze also contribute to visibility degradation through the absorption and scattering of radiation by gases and particulates (Elsom, 1996).

Other environmental impacts associated with air pollution include loss of biodiversity, damage to sensitive environments and acid rain. Acid rain is a general term referring to a combination of wet and dry deposition from the atmosphere containing elevated amounts of sulphuric and nitric acid. Acid rain occurs when gases, primarily NO_2, SO_2, CO (emitted from industrial and natural processes) dissolve in water, either in the atmosphere or on the ground, to form various acids (Metah, 2010). This increases the acidity of soil and affects the chemical balance of dams and rivers. Acid rain can also cause damage to buildings and infrastructure, and has become an even more serious concern over the last two decades (Fan et al., 2010).

5.4 ENVIRONMENTAL IMPACT

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5.5 IDENTIFYING EMISSION SOURCES FROM PLANNED ACTIVITIES

The proposed activities have the ability to generate dust and other air emissions and if uncontrolled, could become a nuisance. Table 2 provides a list of expected activities associated with the planned activities. These activities are used to represent the potential points/localities of air pollution sources.

Table 2: Description of planned activities and emissions

ACTIVITY DESCRIPTION	POSSIBLE EMISSIONS FROM ACTIVITIES
Paved and Tar Roads	Vehicle emissions (CO, CO_2, VOC), particulate matter and dust deposition.
Mobile Equipment for trenching (Front End Loader, Bulldozer, and ADT)	Particulate matter, CO, CO_2 and VOC
Stationary Equipment (Crusher, R&D Pilot Plant, Hoist and Winder)	Particulate Matter.
Waste management	Particulate Matter and offensive odours.
Stockpiling of materials	Particulate Matter.
Earthworks	

(orange)	Medium to high expected impact
(yellow)	Low to medium expected impact
(blue)	None to low expected impact

6 SAMPLING

6.1 ACTIVE INDICATIVE SAMPLING

Results obtained from active indicative sampling is evaluated against ambient air quality limits for any common pollutants (SANS 1929:2011) as in Table 3 below (as per hourly averaged limits). Out of the set of possible pollutants measured during the study, there are limits as set out under SANS 1929:2011. See below:

- Particulate Matter (PM_{10}): 0.12 mg/m^3; and
- Carbon Monoxide: 30 mg/m^3.

For the carbon monoxide, no set limit is provided. However, the verified global average is used as a limit and limit is thus set at:

- CO_2: 350 ppm.

Table 3: Ambient air quality limits for common pollutants (SANS 1929:2011) (Limit Values in µg/m^3)

Pollutant	Averaging Period	Limit Value	Frequency of Exceedance	Compliance Date
Sulphur dioxide SO_2	10 minute average	500 (191)	526	Immediate
	1-hr average	350 (134)	88	Immediate
	24-hr average	125 (48)	4	Immediate
	Annual average	50 (19)	0	Immediate
Nitrogen dioxide NO_2	1-hr average	200 (106)	88	Immediate
	Annual average	40 (21)	0	Immediate
Carbon monoxide CO	1-hr average	30 000 (26 000)	88	Immediate
	8-hourly running average	10 000 (8 700)	11	Immediate
Ozone O_3	8-hourly running average	120 (61)	11	Immediate
Particulate Matter PM10	24-hr average	120	4	Immediate – 31 December 2014
	24-hr average	75	4	1 January 2015
	Annual average	50	0	Immediate – 31 December 2014
	Annual average	40	0	1 January 2015
Lead Pb	Annual average	0.5	0	Immediate
Benzene C_6H_6	Annual average	10 (3.2)	0	Immediate – 31 December 2014
	Annual average	5 (1.6)	0	1 January 2015

7 EMISSION GENERATION

It is important to predict and determine possible areas of emission generation as early identification can help develop mitigation or prevention plans for the specific emission generating activities. A prediction is made possible by using existing examples of emission generating activities on other sites and its effect and measures set in place to mitigate these. As almost all mining activities and related processes are based on the same principle, it is reasonable to assume that the dust fallout for similar activities would be comparable.

From the activities proposed for this project the following can be expected to be activities that can cause or lead to the generation of emissions:

Construction Phase:

- Site establishment including fencing and security;
- Site and vegetation clearing;
- Soil stripping, earthworks and diggings;
- Storage of waste and construction materials;
- Materials transport;
- Foundations and constructions;
- Surfacing; and
- Finishing etc.

During the Operational phase:

- Vehicle movement;
- Trenching
- Drilling;
- Crushing; and
- Operational emissions.

By assessing the possible emission generating activities, it can be assumed that a quantifiable amount of emissions will be generated on site and that would possibly require mitigation measures.

7.1 PREDICTED AREAS OF INFLUENCE

The possibility of emissions becoming a nuisance is determined by various factors. Specifically, PM_{10} (dust) is mostly transported by air movement and as such wind and wind intensity can help determine the effective range of travel of pollutants. To determine possible areas that could be affected the wind rose data must be studied and interpreted. The following section provides an interpretation of the areas that could possibly be affected, by assessing the direction the wind is coming from and the areas the wind would deposit transported dust as reasonably expected.

The following graphs provides an insight into the wind conditions versus the downwind area which would be affected during various periods in the 2018 annual period (station from Upington International Airport).

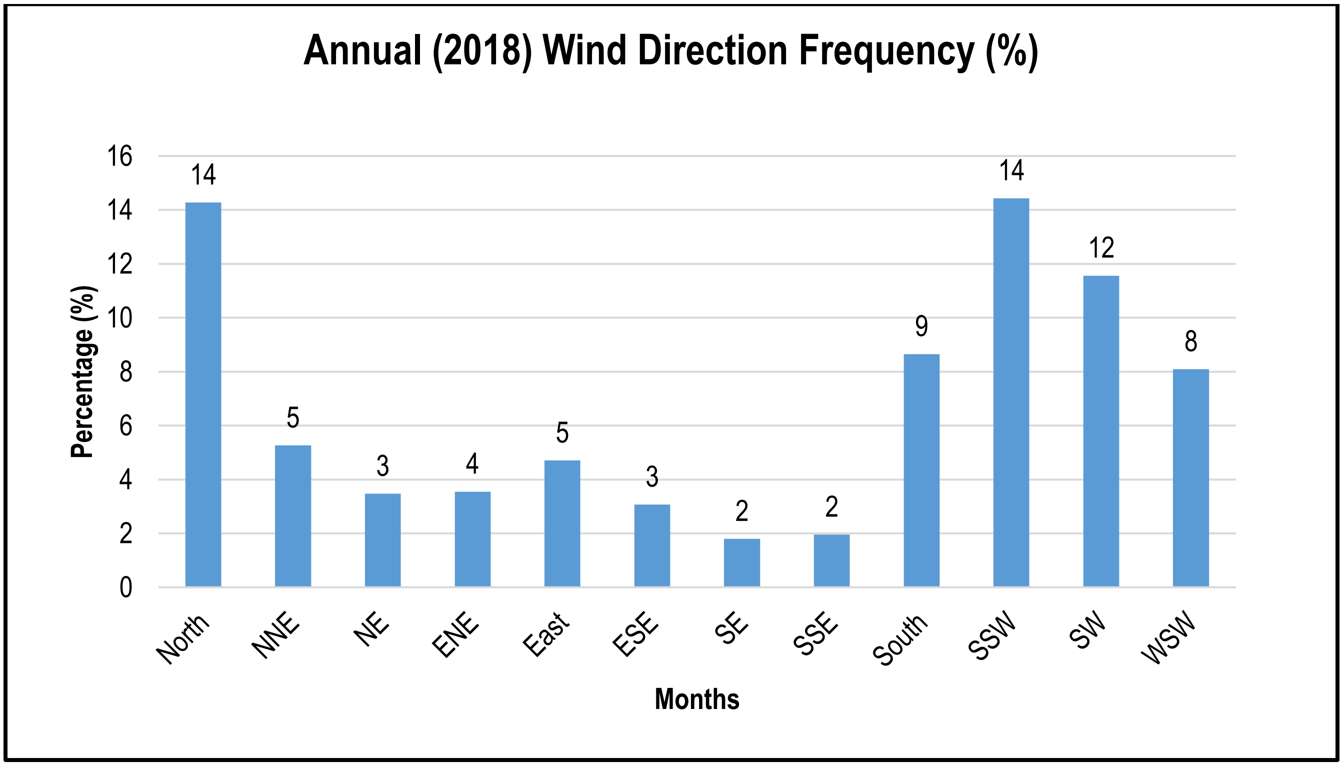

Figure 5: Wind Direction Frequency Average (Upington)

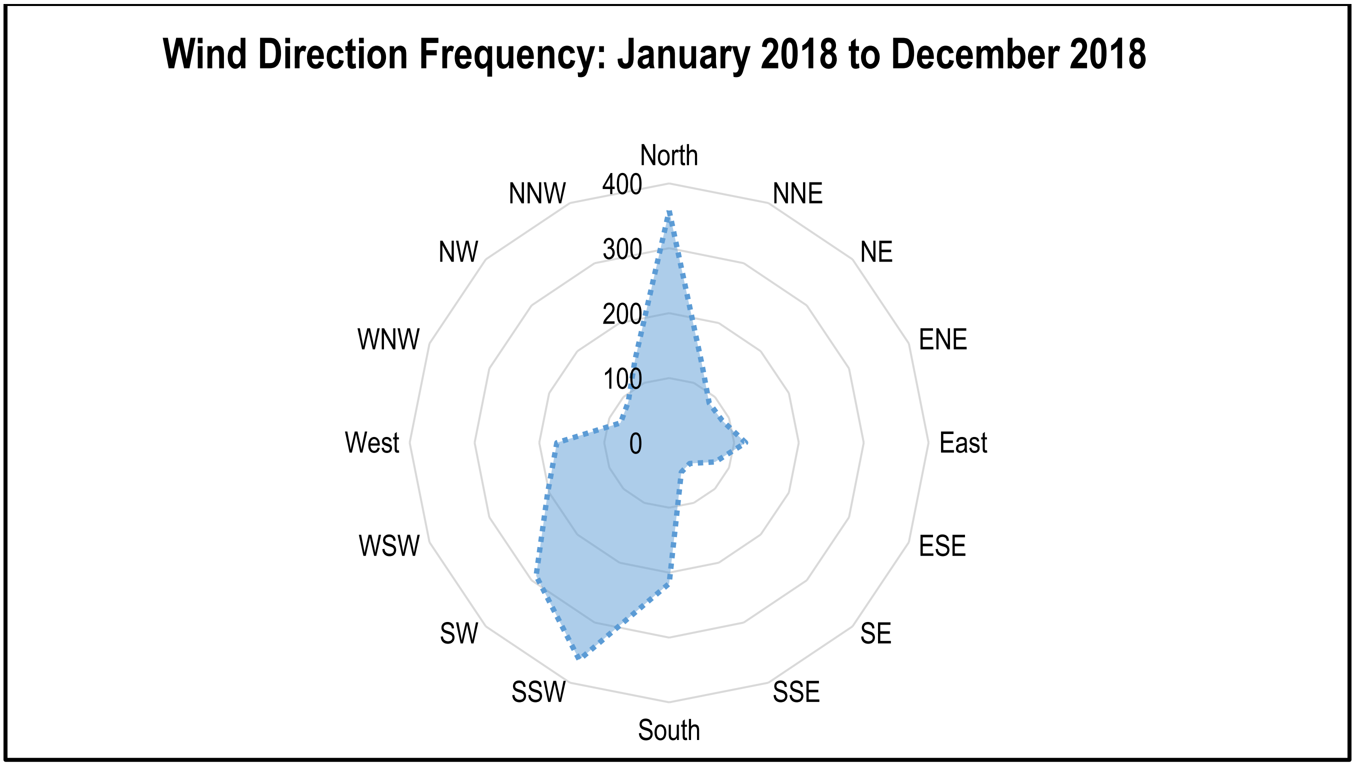

Figure 6: Windrose Diagram (Upington)

Table 4: Total Rainfall and Average Wind Speeds

Rainfall and Windspeed Summary: Jan - Dec 2018		
Day of Month	**Rainfall (mm)**	**Average Wind Speed**
Jan-18	42,6	4,1
Feb-18	69,8	3,8
Mar-18	13,0	3,4
Apr-18	96,6	3,1
May-18	12,6	2,7
Jun-18	0,0	2,2
Jul-18	0,0	3,4
Aug-18	0,0	2,8
Sep-18	2,3	3,2
Oct-18	1,4	3,8
Nov-18	0,0	2,0
Dec-18	0,0	2,2
Total	**238,3**	**-**

Table 5: Wind direction, strength and areas likely to be affected by dust fallout

Period	Main Wind Direction	Other Notable Wind Directions	Area Most Likely To Be Affected	Characteristics Of Affected Area (Area Where Dust Will Settle)
2018	N & SSW	SW, S & WSW	South, north-northeast and north-eastern areas of the site.	Rural Farm Area

From Table 4 & 5 and Figure 5 & 6, it is clear that from the average dominating wind direction data for the Upington area is from a northern and south-south-western direction. Any activities undertaken should in effect impact on areas to the south and north-north-eastern areas of the activities occurring. Moreover, average wind speeds ranged from a light breeze (1.6 – 3.4 m/s) to gentle breeze (3.4 – 5.4 m/s) throughout the annual period, while sporadic increases in wind speeds are also noted throughout the annual period.

8 LIMITATIONS AND ASSUMPTIONS

Due to the timeframe and nature associated with the study, it can be reasonably assumed that only a portion of the actual conditions can be assessed due to a multitude of variables that can affect the ambient air quality. As a result, a twofold approach is used where actual measured data is interpolated with worst case scenarios to determine the current and possible future effect of and on the area under investigation.

It is expected that the area will be further developed. It is therefore vital that the area be assessed in terms of human habitation (presently and in future) so that the current activities identified will not give rise to an unhealthy amount of air pollutant emissions.

The proponent should take heed of all recommendations in this report (and other similar reports) and implement any and all preventative measures. Where authorised emissions of certain pollutants can't be prevented, the proponent must have adequate mitigation measures in place.

Limitations to the study includes, but may not be limited to the following:

- The once-off nature of the assessment cannot account for seasonal or periodical changes in ambient air quality.
- To avoid unsustainable and continued monetary expenditure, only a reasonable amount of time could be allocated for the study. However, every effort to ensure the scientific integrity and objectiveness of the study was taken to present the most accurate results that are as representative of actual environmental conditions as possible.

9 RESULTS

9.1 ACTIVE INDICATIVE SAMPLING

Active indicative sampling is conducted to establish if there are air pollution sources that are emitting such an amount of air pollutants that it can have a negative effect on the environment and/or people. Active indicative sampling is conducted over a minimal timeframe and is just a snapshot of the current situation. Due to the nature of these parameters, it can have negative effects on human health if found in high concentrations. Carbon Dioxide, Carbon Monoxide, Volatile Organic Compounds and PM10 (particulate matter) make out the parameters that are tested for.

Volatile Organic Compounds (VOC's) and Carbon Dioxide (CO_2) are not regulated by the National Environmental Air Quality Act (NEM: AQA, 2004), thus there are no set standards that regulate these parameters.

The effects of inhaling particulate matter (PM_{10}) have been widely studied in humans and animals and include asthma, lung cancer, cardiovascular issues, and premature death. The size of the particle is a main determinant of where in the respiratory tract the particle will come to rest when inhaled. Because of their small size, particles in the order of ~10 microns or less can penetrate the deepest part of the lungs. Larger particles are generally filtered in the nose and throat and do not cause problems, but particulate matter smaller than about 10 micrometres, referred to as PM_{10}, can settle in the bronchi and lungs and cause health problems. The 10-micrometre size does not represent a strict boundary between respirable and non-respirable particles, but has been agreed upon for monitoring of airborne particulate matter by most regulatory agencies.

Carbon dioxide (CO_2) in earth's atmosphere is considered a trace gas currently occurring at an average concentration of about 390 parts per million. Carbon monoxide (CO) is a colourless, odourless, and tasteless gas that is slightly lighter than air. It is toxic to humans and animals when encountered in higher concentrations. Carbon monoxide is produced from the partial oxidation of carbon-containing compounds; it forms when there is not enough oxygen to produce carbon dioxide (CO_2).

Table 6: CO concentrations in the atmosphere

Concentration	Source
0.1 ppmv	Natural atmosphere level
0.5 to 5 ppmv	Average level in homes
5 to 15 ppmv	Near-properly adjusted gas stoves in homes, modern vehicle exhaust emissions
17 ppmv	Atmosphere of Venus
100 to 200 ppmv	Exhaust from automobiles in the Mexico City central area
700 ppmv	Atmosphere of Mars
5,000 ppmv	Exhaust from a home wood fire
7,000 ppmv	Undiluted warm car exhaust without a catalytic converter

VOCs are numerous, varied and ubiquitous. They include both human-made and naturally occurring chemical compounds. Most scents or odours are caused or carried by VOCs. Some VOCs are dangerous to human health or cause harm to the environment.

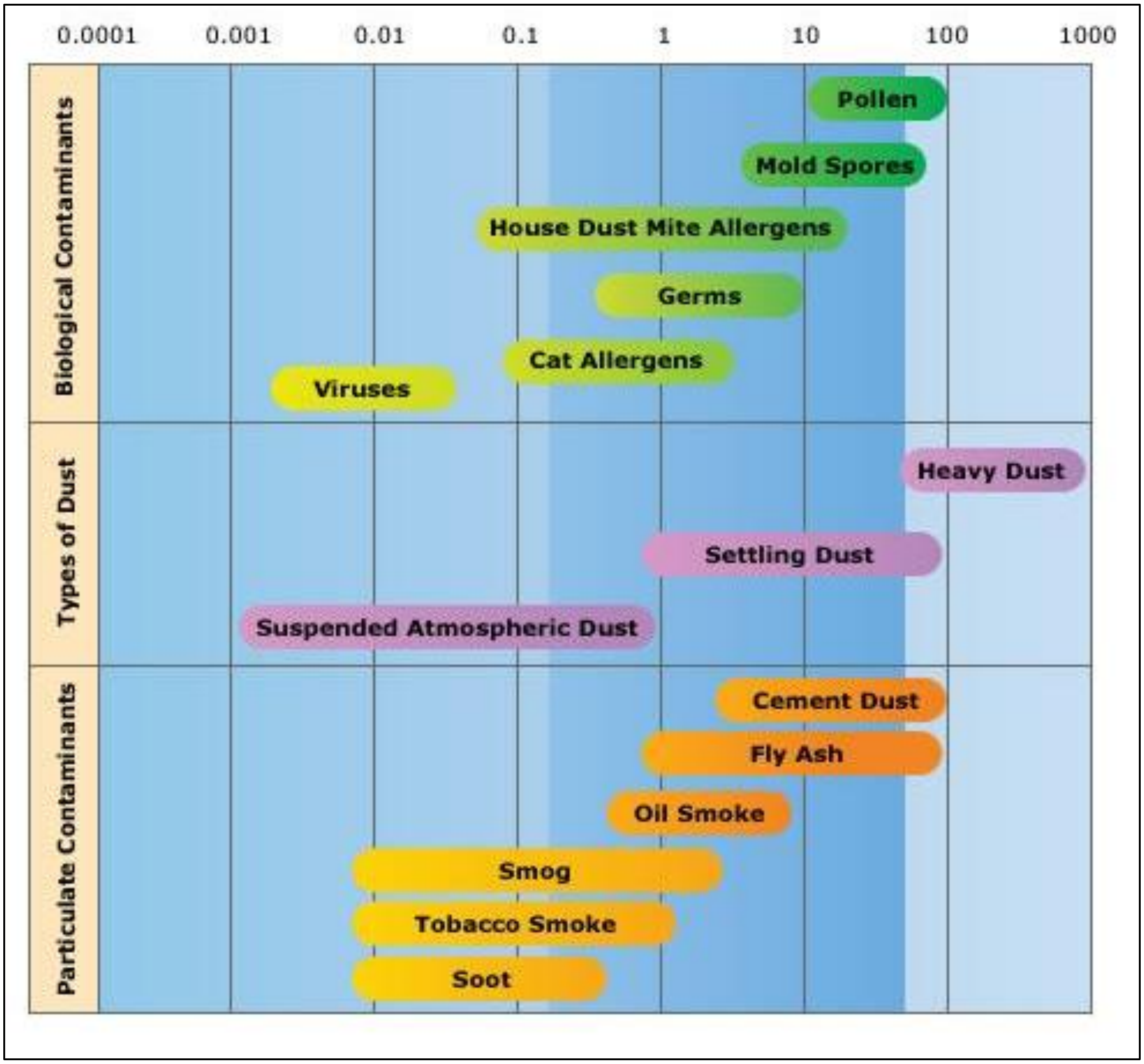

Figure 7: Particulate Matter

9.2 ACTIVE INDICATIVE SAMPLING RESULTS

Table 7: Active Indicative Sampling Results

Farm Areachap 426 Air Quality Data					
	CO_2 (ppm)	CO (ppm)	PM_{10} (mg/m^3)	VOC (ppm)	Temp. (°C)
AQ 1	293	0	0,002	0,30	22,1
AQ 2	325	0	0,002	0,10	22,4
AQ 3	369	0	0,002	0,10	23,0
AQ 4	362	0	0,001	0,00	23,0
AQ 5	374	0	0,003	0,00	23,4
AQ 6	391	0	0,003	0,00	22,8
AQ 7	391	0	0,001	0,00	24,5
AQ 8	416	0	0,003	0,00	25,0
AQ 9	412	0	0,001	0,00	24,9
AQ 10	425	0	0,005	0,00	25,5
AQ 11	482	0	0,004	0,00	26,8
AQ 12	440	0	0,001	0,00	27,0
AQ 13	489	0	0,001	0,00	26,0
AQ 14	494	0	0,028	0,00	28,0
AQ 15	465	0	0,018	0,00	26,4
AQ 16	449	0	0,014	0,00	27,5
AQ 17	463	0	28,984	0,00	28,0
AQ 18	433	0	0,023	0,00	26,6
AQ 19	452	0	0,005	0,00	27,9
AQ 20	445	0	0,048	0,00	28,6
AQ 21	440	0	0,001	0,00	27,5
AQ 22	421	0	0,001	0,00	26,2
Average	419,59	0,00	1,33	0,02	25,60
Minimum	293,00	0,00	0,00	0,00	22,10
Maximum	494,00	0,00	28,98	0,30	28,60

9.3 AIR QUALITY GRAPHS

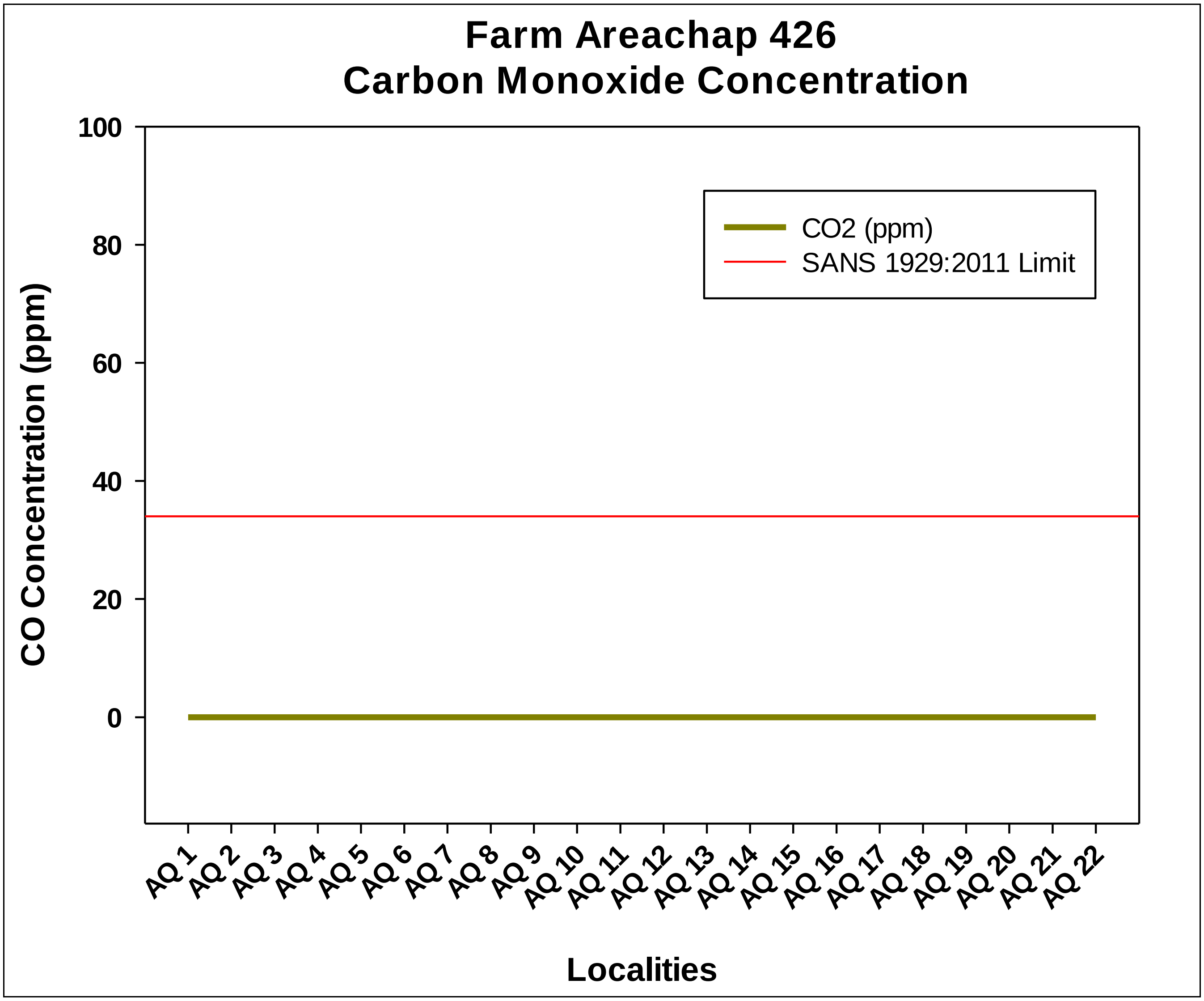

Figure 8: Measured CO concentrations

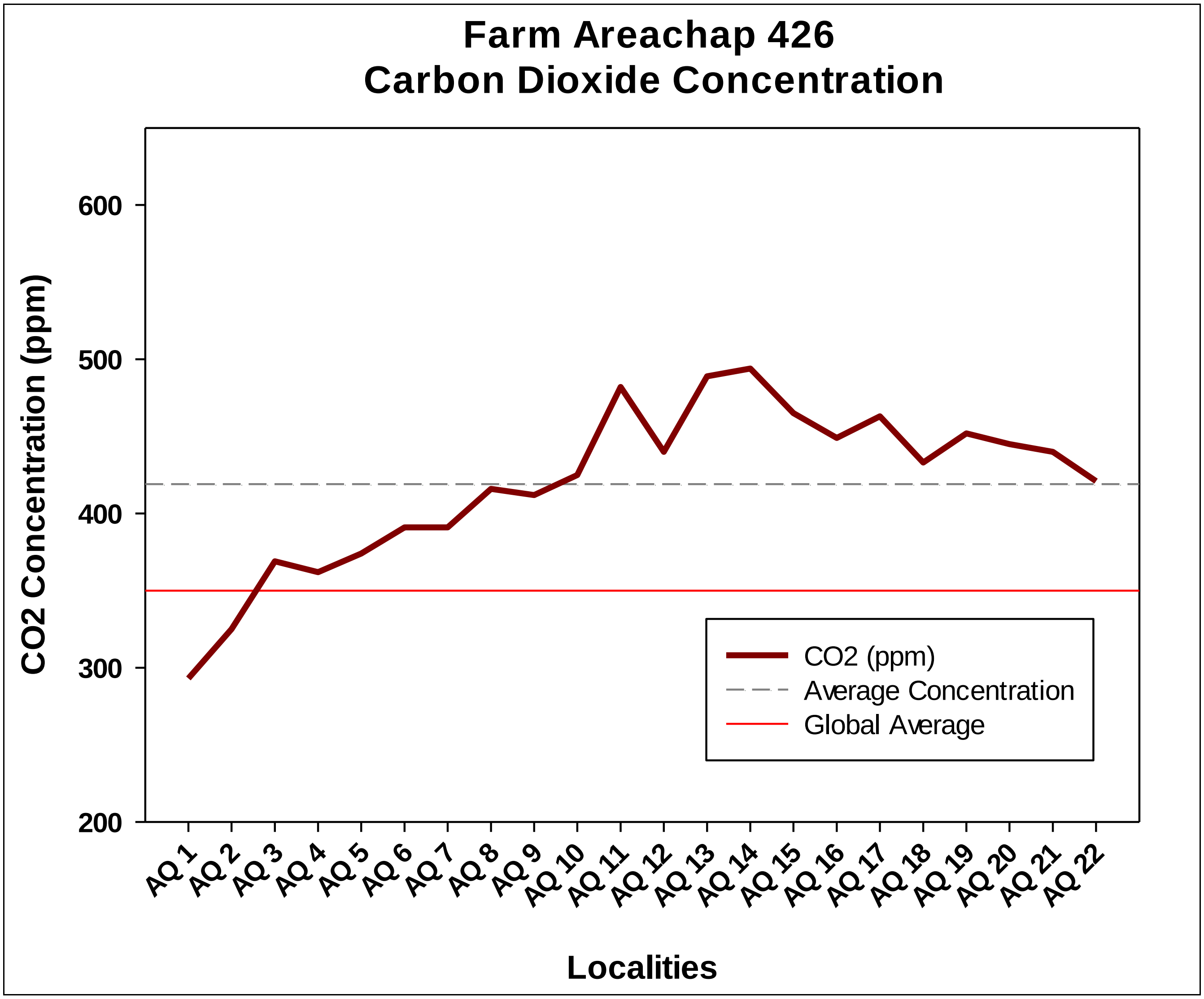

Figure 9: Measured CO_2 concentrations

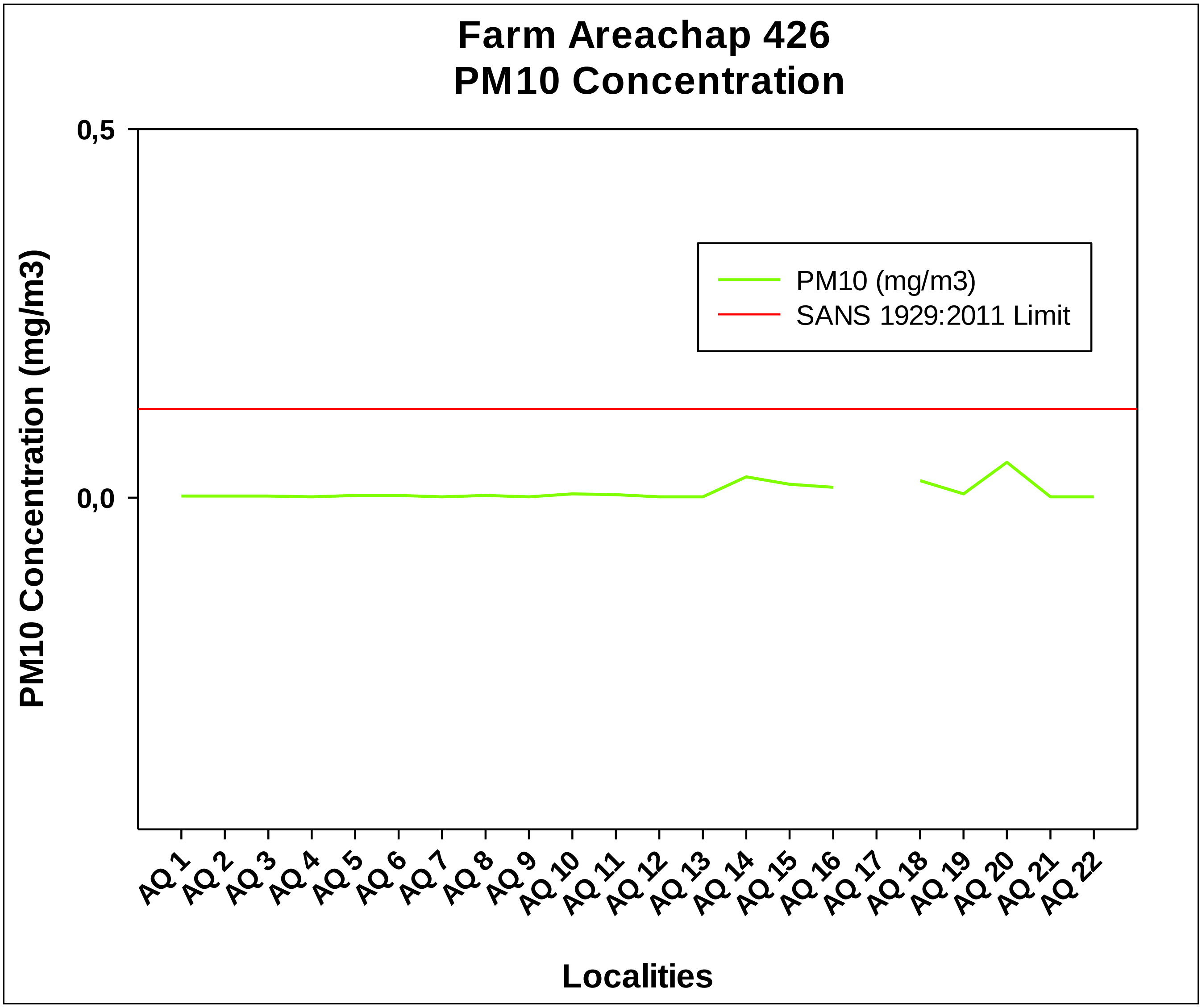

Figure 10: Measured PM10 concentrations (Note that the graph excludes the AQ 17 anomaly)

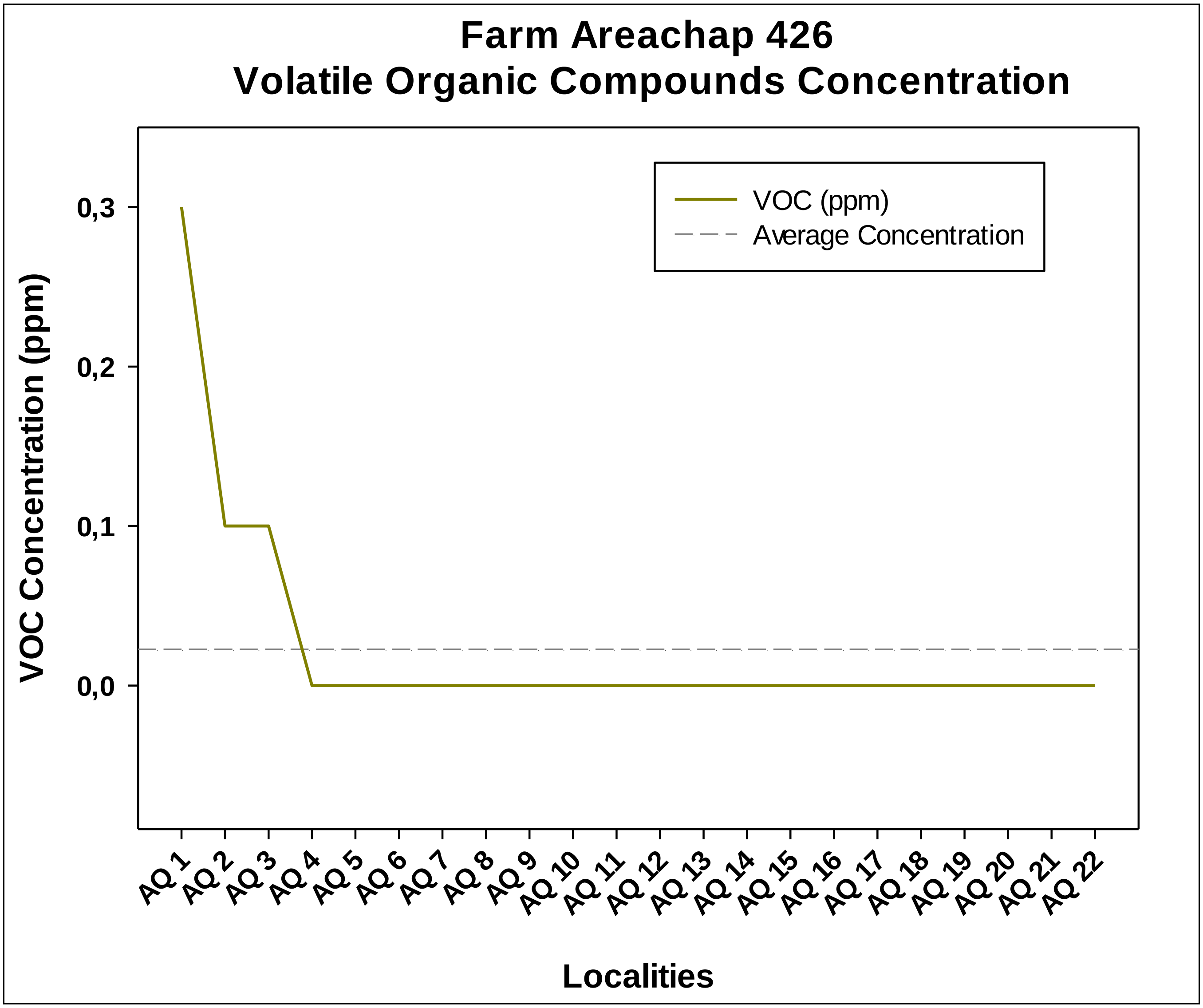

Figure 11: Measured VOC concentrations

9.4 RESULTS – DISCUSSION

Active indicative sampling was undertaken on and around the Areachap 426 prospecting right area. Sensitive receptors included AQ 2 (Offices) and AQ 13 (residential farm house and workforce housing). The results are provided in Table 6 and Figure 7 to 10. Results of the active indicative sampling indicated the following for the assessment:

- Carbon Monoxide:

CO was not detected at any of the monitoring points. This is an ideal result indicating that a definitive impact is not currently present in and around the proposed activity.

- Carbon Dioxide:

All of the sampling localities recorded carbon dioxide during the April 2019 monitoring period. Although some of the detected concentrations were above the global average atmospheric concentration of 350 ppm (parts per million), it should be noted that currently operations are not present and these concentrations are representative of the current non-disturbed ambient air quality conditions. Based the ambient CO_2 concentrations, localities AQ 1 and AQ 2 presented ideal conditions, recording below the global average atmospheric concentration. An average value of 419.59 ppm CO_2 was calculated based on all of the measured concentrations within the study area, while the concentrations ranged from a minimum of 293 ppm at AQ 1 (entrance gate to the proposed core site activity) to a maximum of 494 ppm at AQ 14 (situated ±1.11 km northeast of the proposed core site activity). From the results it is evident that higher CO_2 concentrations (> 400 ppm) were present away from the proposed core activity, reflecting within the proposed impacted and prospecting right boundaries, while concentrations within the core activity area remained below 400 ppm.

- Particulate Matter (PM_{10}):

Particulate matter was measured at all of the monitoring locations during the site assessment. A theoretic calculation is applied based on each individual monitoring concentration to determine compliance with the SANS 1929:2011 24-hour limit of 75 mg/m^3 through the following: The value (measured over 5 minutes) is multiplied by 12 (to get a theoretic value per hour) and finally multiplied by 24 (to get a theoretic value for 24 hours). Based on the calculation, one non-compliance with the 24-hour limit was present at AQ 17. AQ 17 is situated within the western corner of the proposed 119-hectare boundary, and recorded the highest PM_{10} concentration during the site assessment. The concentration as this point is an anomaly which might be attributed to sporadic wind conditions during the site assessment. All remaining localities revealed extremely low concentrations during the site assessment (based on a 24-hour cycle) ranging from 0.288 mg/m^3 to 8.064 mg/m^3. All localities excluding AQ 17 recorded ideal concentrations presenting little fine dust generation in the vicinity of the Areachap 426 Farm study area.

- Volatile Organic Compounds:

When ambient concentrations are considered, volatile organic compounds were measured at three monitoring points which included:

  - AQ 1 which is located at the entrance gate to the proposed core site activity – 0.3 ppm;
  - AQ 2 situated at the offices of the proposed core activity – 0.1 ppm; and
  - AQ 3 located west of the historical pit within the proposed core activity area – 0.1 ppm

The presence of volatile organic compounds at the proposed core activity might be attributed to evaporation of minor historical spills (presumably vehicle leakages) of solvents and/or motor fuels within the previously prospected/mined area, as well as the from current vehicle activity at the core site. The most common VOC's specifically measured for are methane (CH_4) and ammonia (NH_3). As fine dust is known to carry odours and serve as binding particles of VOC's, a possible relationship between VOC and fine dust emissions may exist. The presence of VOC's within the vicinity warrants a potential concern to sensitive receptors as this area will be the centralised area of employed workforce.

10 FINDINGS

From the active indicative sampling and meteorological data obtained, exceedances may be present within the construction and operational phase in terms of dust generation within the core activity boundary. From the assessment, the measured parameters are currently representative of baseline conditions where windblown particulates may present a problem within the core activity area based on the sporadic wind speeds. The result/s of concern is the concentration of volatile organic compounds which are currently present at the core site activity. A possible relationship between fine dust dispersion and its aid in spreading VOC's is recommended for investigation.

Impacts are likely to be largely local and centralised within the site area, while significant off-site impacts are not expected with regards to the proposed activities. It should be mentioned that an estimation of the impact distance is difficult to determine in terms of the baseline assessment and this can be investigated in terms of a full air quality impact assessment.

11 MITIGATION AND POLLUTION PREVENTION MEASURES

As there is a very high likelihood of dust generation from the proposed activities, mitigation measures are provided. The following tables propose preventative air quality management measures, as required.

Table 8: Proposed Mitigation Measures

Aspect: Stakeholder Communication	
1	Implement a programme of stakeholder communication that includes community engagement before and during work undertaken on site.
2	Provide a complaint register on site where complaints can be made. This register should enable effective communication of complaints where these are reasonably addressed.
3	Clearly display the contact details of the environmental site office and manager at the site entrance.
Aspect: Dust Management	
4	Implement and maintain a Dust and Emission Management Plan which provides clear details on preventing, maintaining and improving the air quality in terms of site-specific activities. This plan could possibly incorporate a dust fallout monitoring programme should it be evident that dust emissions is a problem.
Aspect: Site Management	
5	All complaints should be logged in the complaints register and should be available on the site at all times. All complaints regarding air quality should be adequately investigated and actions taken to reduce the impact in a timely manner should it be required.
6	Note must be taken of incidents that cause air emissions and this must be recorded to ensure that these are resolved and prevented from reoccurring.
Aspect: Monitoring	
7	Weekly site inspections should be undertaken in the vicinity of sensitive receptors. Records should be made of these routine inspections.
8	Should activities be undertaken during dry and windy conditions, special focus must be taken on the impact and results of the conditions to ensure that minimal impact is occurring.
Aspect: Preparing and maintaining the site	
9	Plan the site layout in such a manner as to ensure that emission generating activities occur as far as possible from sensitive receptors. Make use of site offices and large natural barriers.
10	Should the conditions require it, erect screens and barriers around the sensitive receptors.
11	Ensure that all areas, fencing, barriers and scaffolding is kept clear of debris and dust.

12	Remove any accumulating matter that could serve as emission generator from the site as soon as possible.
Aspect: Operating vehicle/machinery and sustainable travel	
13	Ensure that all vehicles are maintained in good working condition and that they are services on regular intervals.
14	Ensure that all vehicles are switched off when stationary – no vehicles should be idling for extended period.
15	Avoid the use of diesel- or petrol-powered generators and use mains electricity or battery powered equipment where practicable.
16	Impose and regulate a speed limit of 30 km/h on the site at all times.
Aspect: Operations	
17	Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g. suitable local exhaust ventilation systems.
18	Ensure an adequate water supply on the site for effective dust/particulate matter suppression/mitigation, using non-potable water where possible.
19	Ensure equipment is readily available on site to clean any dry spillages, and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods.
Waste management	
20	Only use registered waste carriers to take waste off-site
21	Avoid bonfires and burning of waste materials.
Measures specific to earthworks	
22	Re-vegetate earthworks and exposed areas/soil stockpiles to stabilise surfaces as soon as practicable. Use Hessian, mulches or tackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable. Only remove the cover in a small area during work and not all at once.
Aspect: Measures specific to construction	
23	Ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place.
24	Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in appropriate storage with suitable emission control systems to prevent escape of material and overfilling during delivery.
25	For smaller supplies of fine power materials ensure bags are sealed after use and stored appropriately to prevent dust.
Aspect: Measures specific to track-out	
26	Use water-assisted dust sweeper(s) on the access and local roads, to remove, as soon as practicable any material tracked out of the site. This may require the sweeper being continuously in use.
27	Avoid dry sweeping of large areas.

28	Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport.
29	Record all inspections of haul routes and any subsequent action in a site log book.
30	Install hard surfaced haul routes, which are regularly damped down with fixed or mobile sprinkler systems, or mobile water bowsers and regularly cleaned.
31	Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as practicable;
32	Access gates to be located at least 10m from receptors where possible.

Table 9: General Management Measures

Aspects	Management action or objective	Responsible Person(s)	Timeframe
Removal of Vegetation Land clearing Excavation Material Transport Material Handling Construction	• Spray areas to be cleared with water. • Ensure minimum travel distance between working areas and stockpiles. • Ensure that topsoil for stockpiles is sprayed with water before tipping to prevent dust generation. • Ensure graded areas are sprayed with water. • Minimise the amount of graded areas. • Ensure that shortest routes is used for material transport. • Load and offload material, as far as possible, downwind of stockpiles. • Actively monitor dust fallout generated in the 8 major wind directions on the borders of the site. • Implement monthly site inspection to check for possible areas of dust generation not addressed or not effectively managed.	Environmental Site Officer Contractors & Sub-Contractor Safety and Environmental Officers	Duration of the construction phase

12 CONCLUSION AND RECOMMENDATIONS

The air quality measured in the proposed prospecting area is in a relatively good condition as per the results obtained. Some of the detected CO_2 concentrations were above the global average atmospheric concentration, while it should be noted that currently operations are not present and these concentrations are representative of the current non-disturbed ambient air quality conditions. Volatile organic compounds were measured at three monitoring points (AQ 1, AQ 2 and AQ 3) which are located at the entrance gate to the proposed core site activity, the offices of the proposed core activity and west of the historical pit. The presence of volatile organic compounds at the proposed core activity might be attributed to evaporation of historical spills of solvents and/or motor fuels within the previously prospected/mined area. The presence of VOC's within the vicinity warrants concern to sensitive receptors as this area will be the centralised area of employed workforce. Based on the assessment pertinent "no-go" areas are not deemed necessary in terms of the project.

It is assumed that the construction and prospecting of the bulk-sampling of the development will contribute to the total suspended load in the atmosphere, although off-site impacts are not expected and the impact is anticipated to be largely local and centralised within the site area. From the active indicative sampling and meteorological data obtained, exceedances may be present within the construction and operational phase in terms of dust generation within the core activity boundary. In order to ensure and prevent this possible outcome, pertinent measures are provided in this report to enable the proposed development to minimise the impact. An estimation of the impact distance is difficult to determine in terms of the baseline assessment which can be investigated in terms of a full air quality impact assessment.

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