BASELINE AIR QUALITY ASSESSMENT REPORT

BASELINE AIR QUALITY FOR THE PROPOSED MINING RIGHT FOR TENBOSCH PTY LTD ON FARMS TENBOSCH 162 AND TURFBELT 593 TENBOSCH, MARLOTH PARK, MPUMALANGA PROVINCE, SOUTH AFRICA

REFERENCE NUMBER: NOVBAQ
CLIENT: TENBOSCH MINING (PTY) LTD

03 AUG, 2023

DOCUMENT CONTROL

Item	Description		
Proposed development and location	The proposed establishment of a mine within the Tenbosch Farm Area		
Purpose of the study	To carry out a Baseline Air Quality Assessment study for the proposed establishment of a mine in the Tenbosch area		
Coordinates	Section 2, Page 6		
Municipalities	Nkomazi Local Municipality		
Predominant land use of surrounding area	Cultivation and Tourism		
Applicant	Tembosch Mining (Pty) Ltd		
Prepared for:	kimopax GROUP Inspire | Enhance | Innovate		
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Date of Report	30/07/ 2023		
DRAFT DOCUMENT	**Prepared by:** **Nonhlanhla Mogakane**	**Reviewed by:**	**Approved by:**
Date: **03 August 2023**	**Signature:**	**Signature:**	**Signature:**

DECLARATION OF INDEPENDENCE

I, **Nonhlanhla Veronica Mogakane** do hereby declare that I am financially and otherwise independent of the client and their consultants, and that all opinions expressed in this document are substantially my own, notwithstanding the fact that I have received fair remuneration from the client for preparation of this report.

Expertise:

Nonhlanhla Veronica is an Environmental, Social and Sustainability expert with 6 years of experience. She specialises in Strategic Environmental and Sustainable Development projects, Climate Change and Health, Air Quality, Environmental Management issues and Construction Supervision of all infrastructural projects.

Independence

The views expressed in this document are the objective, independent views of NV Mogakane and the survey was carried out for KMG Environmental Solutions Services (Pty)Ltd. NV Mogakane has no other business, personal, financial or other interest in the proposed development apart from fair remuneration for the work performed.

Conditions relating to this report

The content of this report is based on the author's best scientific and professional knowledge as well as available information. KMG Environmental Solutions Services (Pty)Ltd reserves the right to modify the report in any way deemed fit should new, relevant or previously unavailable or undisclosed information become known to the author from on-going research or further work in this field, or pertaining to this investigation.

This report must not be altered or added to without the prior written consent of the author and the client. This also refers to electronic copies of the report which are supplied for the purposes of inclusion as part of other reports, including main reports. Similarly, any recommendations, statements or conclusions drawn from or based on this report must make reference to this report. If these form part of a main report relating to this investigation or report, this report must be included in its entirety as an appendix or separate section to the main report.

Authorship: This Baseline Air Quality Assessment Report has been prepared by Nonhlanhla Mogakane who is also an Air Quality and Sustainability Specialist. The report is for the review by KMG Environmental Soultions Services (Pty)Ltd.

Geographic Co-ordinate Information: Geographic co-ordinates in this report were obtained using a hand-held Garmin Global Positioning System device. The manufacturer states that these devices are accurate to within +/- 5 m.

Maps: Maps included in this report use data extracted from the ArcGIS and Google Earth Pro.

Disclaimer: The Authors are not responsible for omissions and inconsistencies that may result from information not available at the time this report was prepared.

Signed by:

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03/08 2023

ACKNOWLEDGEMENTS

The authors acknowledge Tenbosch Mining for their assistance with project information, and the associated project background Information as well as responding to technical queries related to the project.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS AND KEY CONCEPTS

Climate & Meteorology

ITCZ	Inter Tropical Convergence Zone
WD	Wind Direction
WS	Wind Speed
Direction	
N	North
NNE	North North East
NE	North East
ENE	East North East
E	East
ESE	East South East
SE	South East
SSE	South South East
S	South
SSW	South South West
SW	South West
WSW	West South West
W	West
WNW	West North West
NW	North West
NNW	North North West

Legislation

AQIA	Air Quality Impact Assessment
AQMP	Air Quality Management Plan
BAR	Basic Assessment Report
EA	Environmental Authorisation
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EMPr	Environmental Management Programme
ESIA	Environmental and Social Impact Assessment
NEM: AQA	National Environmental Management: Air Quality Act No. 39 of 2004
NEMA	National Environmental Management Act No. 107 of 1998
OMP	Odour Management Plan
VEC	Valued Environmental and Social Component

Measurement

°	Degrees
°C	Degrees Celsius
µg	Microgram
$\mu g/m^3$	Microgram per cubic metre
µm	Micron
g/s	Grams per second
K	Kelvin
km	Kilometre

km/h	Kilometre per hour
m	Metres
m/s	Metres per second
m^3	Cubic metres
mg	Milligrams
$mg/m^2/day$	Milligrams per meter squared per day
mg/m^3	Milligrams per cubic metre
mg/Nm^3	Milligrams per normal cubic metre
mm	Millimetre
Nm^3	Normal cubic metres
ppb	Parts per billion
ppm	Parts per million
t/day	Tons per day
t/hr	Tons per hour
tpa	Tons per annum

Organisations

I&AP's	Interested and Affected Parties
IFC	International Finance Corporation

Particles & Chemicals

C_6H_{14}	Hexane (-n)
$C_6H_4(CH_3)_2$	Xylenes (mixed isomers)
$C_6H_5CH_2CH_3$	Ethyl benzene
$C_6H_5CH_3$	Toluene
$C_6H_5CHCH_2$	Styrene
CH_3SCH_3	Dimethyl Sulphide
$CH_3S\text{-}H$	Methyl Mercaptan
CH_3SSCH_3	Dimethyl Disulphide
CH_4	Methane
CO	Carbon Monoxide
CO_2	Carbon Dioxide
H_2S	Hydrogen Sulphide
H_2SO_3	Sulphurous Acid
H_2SO_4	Sulphuric Acid
NaOH	Caustic soda / Sodium Hydroxide
NO	Nitrogen Oxide
NO_2	Nitrogen Dioxide
NOx	Nitrogen Oxides
PGI	Propylene Glycol Industrial Grade
PM	Particulate matter
PM_{10}	Particulate matter with an aerodynamic diameter of less than 10 microns

$PM_{2.5}$	Particulate matter with an aerodynamic diameter of less than 2.5 microns
SO_2	Sulphur Dioxide
TRS	Total Reduced Sulphur
TSP	Total Suspended Particulates
VOC	Volatile Organic Carbon

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EXECUTIVE SUMMARY

Tenbosch Mining (Pty) Ltd is applying for a Mining Right Application within the Marloth Park area. Tenbosch Mining will be an underground mining operation. The approximate extent of the underground mining area is 6 251 ha, and the proposed coal mining will be by decline method. There is an alternative to use a single or twin decline shafts which will comprise of two parallel shafts, one dedicated to personnel and material movement and one dedicated to coal conveying.

These will be the up and down cast ventilation tunnels for the mine, but up-cast raise bore ventilation shafts will be developed once required and these two declines will both be downcast. Raise bore ventilation holes will be developed as part of on-going capital as mining progresses.

Bord-and-pillar mining method is proposed for dipping coal seams. This entails the mining of rooms (bords) leaving pillars intact as a primary support to support the immediate roof. Secondary support will be used in the form of roof bolts and any other support means as and when required into the immediate roof of the bords mined.

The Tenbosch Mine is planned as a conventional underground mining operation. The proposed infrastructure development includes:

- The shaft bank area (for the main and ventilation shafts and the immediate infrastructure associated therewith including the winder houses, the ventilation fans, materials handling equipment etc.);
- The ROM ore storage areas and underground development waste rock areas;
- Crushing and screening plant;
- Sales product storage areas and load out areas;
- Tailings storage facility;
- Surface substations and the like;
- Main access road from the N4 to the mine site,
- Stormwater management infrastructure;
- A pollution control dam;

- Buildings including workshops, change house-lamp room, offices, stores;
- Contractors' laydown area and parking;
- Power Supply infrastructure including a switching yard and electrical powerlines;
- Sewerage treatment package plant;
- Water Treatment Plant, Fuel storage, and water infrastructure including portable water

Measures to mitigate the impact of the Project on both the natural and social environment will be implemented in line with the EMPr and Tenbosch policy documents. This project will among other things result in job creation, increase in tax revenue and development of social infrastructure.

The objective of the AQA is to provide detail of the Air Quality baseline conditions, within the proposed site and surrounding related areas, in order for the EAP to assess the potential direct, indirect and cumulative impacts of the proposed Tenbosch Mine. The AQA study comprised two phases: a desktop assessment of the local and regional context; site visits and investigation into the local context and potential air quality impacts of the project.

The assessment was conducted to establish the ambient air quality baseline conditions, followed by the development of an air emissions inventory that will take into account the relevant sources of air pollution and associated air emissions.

The overall Air Quality impact of the proposed Tenbosch Mine is likely to be directly related to a number of factors including the impact of the mine on natural resources (and local livelihoods). To determine the baseline conditions, site specific monitoring was done between 22 June 2023 and 28 July, 2023 using Polludrone Ambient Air Qulaity Monitoring System device. The following parameters were monitored;

- Carbon Monoxide (CO)
- Nitrogen Oxide (NO)
- Nitrogen Dioxide (NO_2)
- Sulphur Dioxide (SO_2)
- $PM_{2.5}$

- PM_{10}
- Ozone (O_3)

An emissions inventory has been developed to determine pollutants from various sources. The conclusion reached in this reported is informed by observed and monitoring data and an analysis of potential air quality pollutants that will be associated with the mine.

The findings from this study should inform mine management on the modelling, monitoring and strict mitigation measures to ameliorate potential atmospheric impacts. Some of the numerous mitigation measures recommended are listed below:

- The area of disturbance should be kept to a minimum and no unnecessary clearing, digging or scraping must occur, especially on windy days (with wind speed ≥ 5.4 m/s).
- The drop heights when loading onto trucks and at tipping points should be minimised.
- Use of dust suppressants and binders on haul roads to reduce dust generation.
- There is need to minimise travel speed and distance. Dust generating capacity of particles less than 10 µm is contained by 58% when vehicle speed is reduced from 25 mph (40 km/h) to 15 mph (24 km/h).
- On rainy seasons the nearby tar roads must be kept free of muddy tracks from truck from the mine. This will avoid dust generation once dry within the area.

These management and mitigation measures will require dedicated resources from Tenbosch Mine to ensure they are effective. These measures also need to be implemented prior to the commencement of the construction phase, and carried out throughout the operational and closure phases of the mine to minimise negative Air Quality impacts, and maximise positive impacts.

PART ONE

1. BACKGROUND

1.1. INTRODUCTION

Tenbosch Mining (Pty) Ltd, the proponent represented, is currently in the process of applying for an underground mining right for coal within the Tenbosch area, Marloth Park, Mpumalange Province. KMG Environmental Solutions Services (Pty)Ltd was appointed by Kimopax on behalf of Tenbosch Mining as an Air Quality specialist to undertake the Baseline Air Quality Assessment (AQA) for the project. As part of the feasibility studies currently underway, an AQA is required to identify and evaluate the air quality status quo within the project area and possible impacts based on the proposed activities.

1.2. PROJECT OVERVIEW

The mine will be operated as an underground mine within the proposed footprint.

1.3. PURPOSE OF THE BASELINE AIR QUALITY ASSESSMENT (AQA)

This document serves to complement the feasibility studies for the proposed mining activity and outline how air quality issues and risks of the project may be assessed and managed in accordance with the relevant Legislations and standards. The AQA study comprised two phases in order to facilitate the environmental authorisation requirements. Firstly, a prefeasibility phase, which comprised an assessment of the local and regional context and identified potential air quality impacts of the proposed project. Secondly, a baseline scoping phase, which included site visits and investigation into the local context and potential air quality impacts of the project.

1.4. APPROACH OF THE STUDY

The assessment will establish the current ambient air quality baseline conditions, followed by the development of an air emissions inventory that will take into account the relevant sources of air pollution and associated air emissions.

1.5. COMPONENTS OF AQA

The role of an AQA as part of any project cannot be downplayed as it aids in providing a better understanding of the baseline conditions of the affected and nearby communities who make up the project area. The tasks outlined in this report will be achieved by:

- A review of indicators with every data that can be found from different sources.
- Baseline pollutant assessments in the Tensbosch Area
- Review of legislation and policies of the geographical area.
- Review of information from other specialist studies undertaken for the project and other comparable projects.

1.6. TERMS OF REFERENCE

This AQA will form part of the compilation of various technical reports that will be included in the Environmental Impact Assessment (EIA). This study aims to investigate the baseline conditions of ambient air quality within the area. The terms of reference for the baseline air quality assessment are set out below:

Baseline Air Quality Report

- Identification of existing air pollution sources.
- Identification of air quality-sensitive receptors, including any nearby residential dwellings and proposed receptors in the vicinity of the project.
- Document the legislative and regulatory context, including limits and standards.
- Document local weather conditions.
- Provide meteorological data (hourly average wind speed, wind direction and temperature data.

- Wind field, mixing depth and atmospheric stability.
- Assessment of baseline air pollution.
- Briefly Identify potential impact issues and risks to be assessed during the impact assessment and reporting phase and matters that could affect the project layout and design and selection of project alternatives.

1.7. ASSUMPTION AND LIMITATIONS

Data limitations and assumptions associated with this study are listed below:

- This impact assessment is limited to the following parameters;
  - Carbon Monoxide (CO)
  - Nitrogen Oxide (NO)
  - Nitrogen Dioxide (NO_2)
  - Sulphur Dioxide (SO_2)
  - Ozone (O_3)
  - $PM_{2.5}$
  - PM_{10}
- This assessment did not include tail pipe emissions from vehicles.
-

PART TWO

2. PROJECT AREA

2.1. STUDY SITE LOCALITY

The project is located within the Mpumalanga Province near the Lebombo Boarder post into Mozambique. The footprint of the whole proposed project lies within various farms within the Tenbosch, Marloth Park area which fall within the jurisdiction of the Nkomazi Local Municipality.

On the bank of the Crocodile River between Malelane and Komatipoort on the N4 national highway, Marloth Park is a wildlife sanctuary and holiday town. It boasts four of the “Big Five” with the exception of elephant. Buffalo, rhino and lion are confined to Marloth's game reserve "Lionspruit"; the rest of the game such as kudu, zebra, giraffe, blue wildebeest, nyala, impala, warthog, ostrich and others aren't restricted by fences and roam freely between the units that are built on 3000 ha.

The southern boundary of Marloth Park runs along the southern border of the Kruger National Park. This means that there is no physical fence separating Marloth Park from Kruger National Park, allowing wildlife to roam freely between the two areas. As a result, Marloth Park offers a unique opportunity for visitors to experience a close encounter with wildlife, including various species of birds, antelopes, zebras, giraffes, and other smaller mammals, that regularly move between the two parks.

While Marloth Park itself is a residential and holiday destination with private lodges and houses, as well as commercial farming. The nearest entrance gate from Marloth Park is the Crocodile Bridge Gate, which is approximately 15 kilometers away. The Crocodile Bridge Gate is known for its excellent wildlife sightings and is a popular entry point into the southern region of the Kruger National Park.

Overall, the close proximity of Marloth Park to the Kruger National Park makes it an appealing destination for nature enthusiasts.

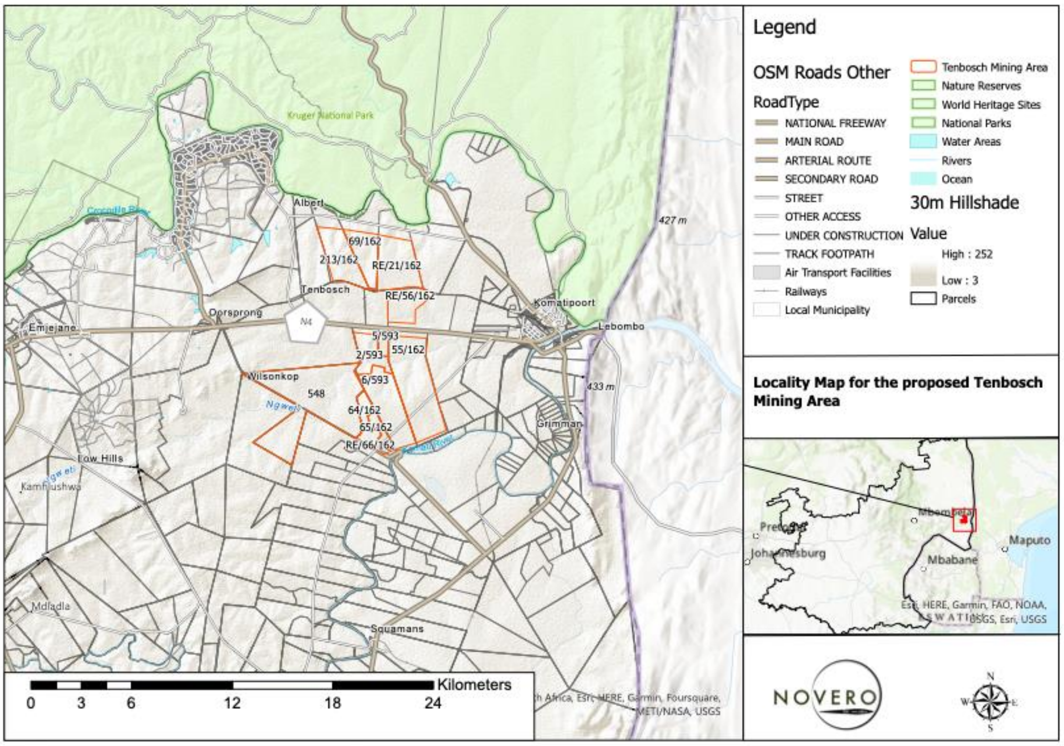

FIGURE 1 SITE LOCALITY

2.2. GPS COORDINATES OF THE BOUNDARIES

The GPS coordinates of the some of the boundary demarcation within the project area are contained in the map.

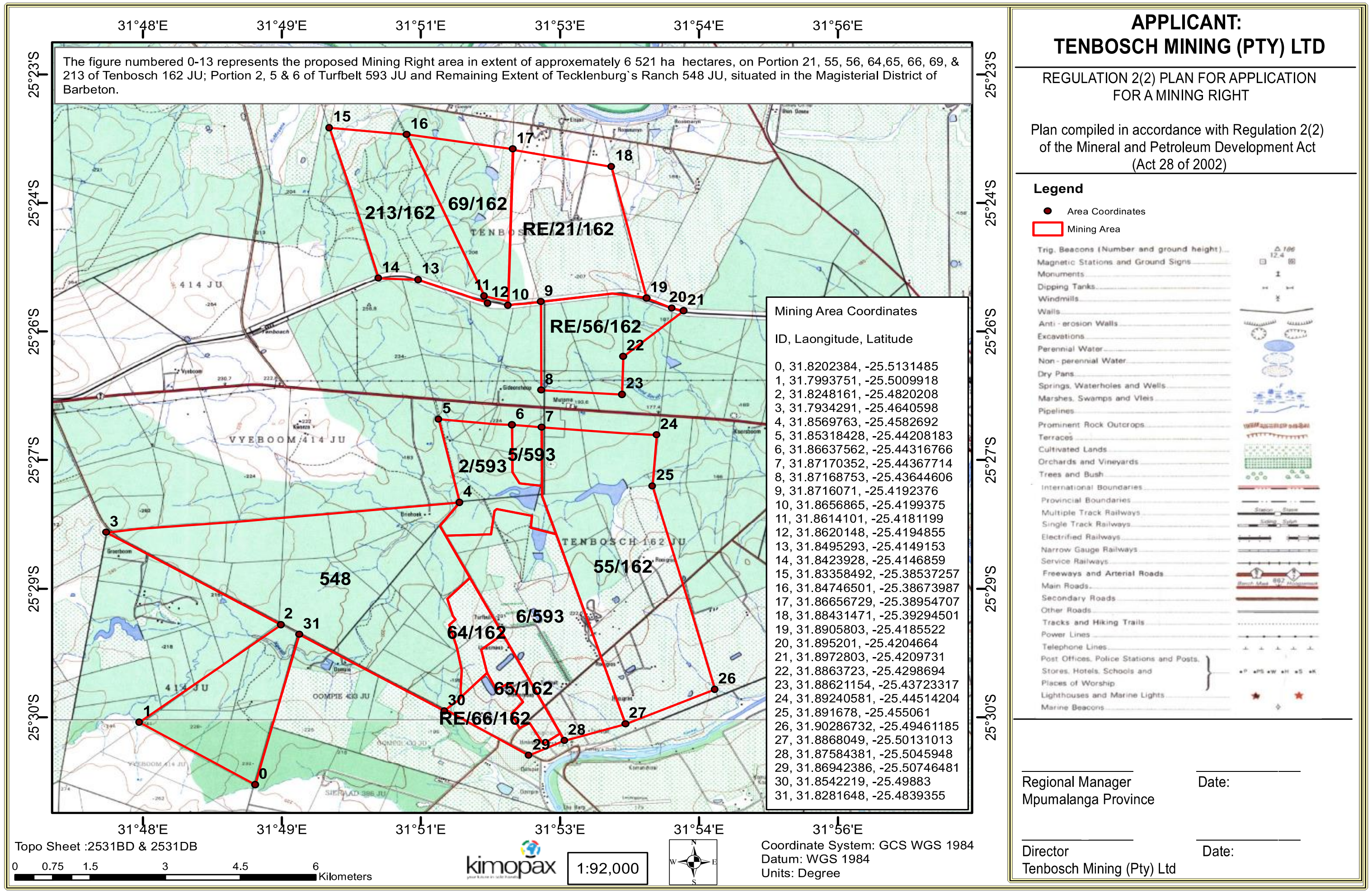

FIGURE 2 FOOTPRINT OVERVIEW

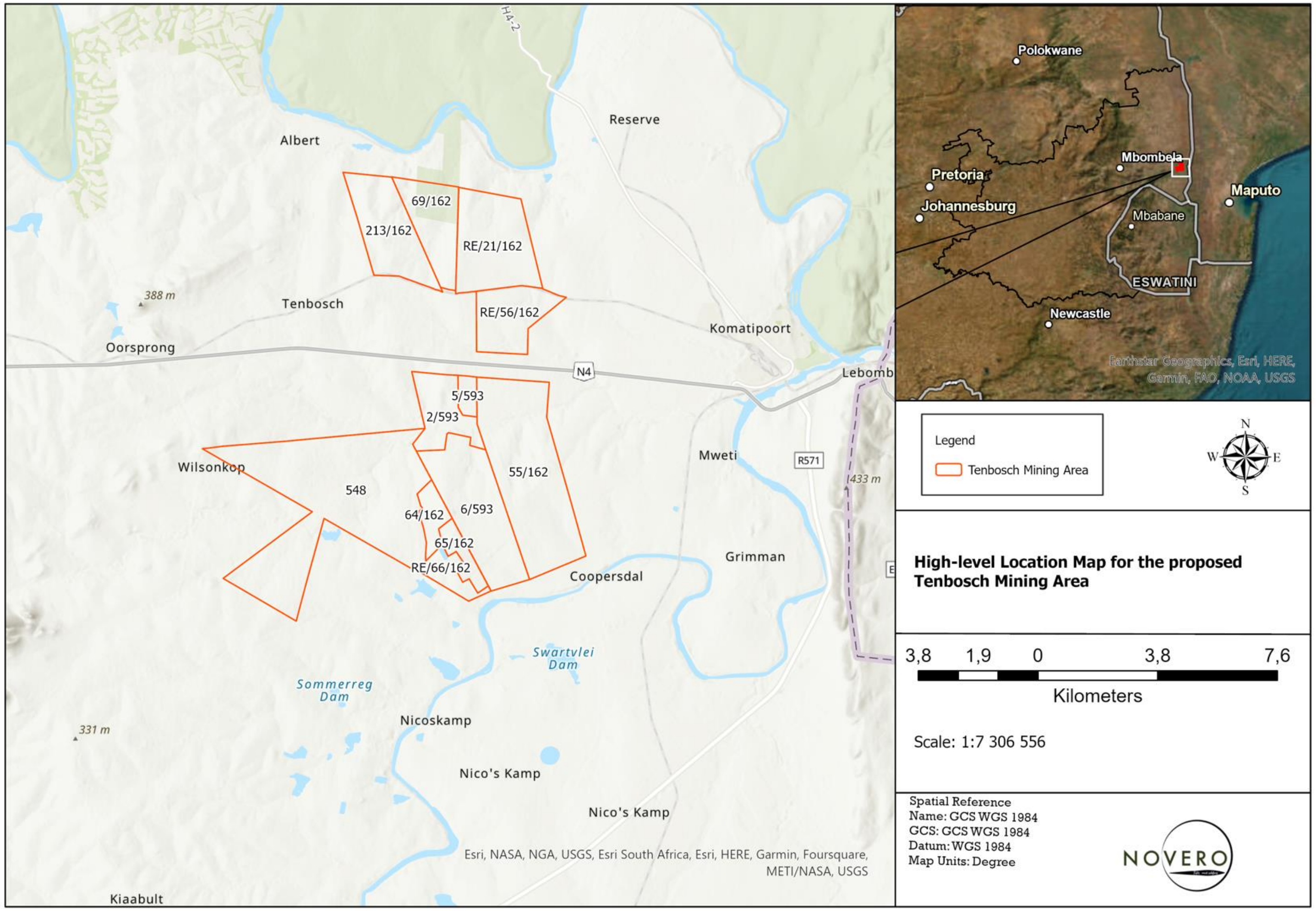

FIGURE 3 HIGH LEVEL LOCALITY MAP

2.3. OVERVIEW OF THE MINING DEVELOPMENT

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The consulting team visited the site on 22/07/2023 all through till 28/07/2023 and picked up that the area is predominantly commercial farming as well as undisturbed within the surrounding areas of the Kruger National Park and Crocodile River.

Figure 4: MINING SITE FOOTPRINT FROM DIFFERENT AREAS

3. LEGISLATIVE AND POLICY GUIDELINE

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 wellbeing World Health Organization (WHO, 2000). Once the guidelines are adopted as standards, they become legally enforceable. These standards prescribe the allowable ambient concentrations of pollutants which are not to be exceeded during a specified time period in a defined area. If the air quality guidelines/standards are exceeded, the ambient air quality is poor and the potential for health effects is greatest.

3.1. THE CONSTITUTION OF SOUTH AFRICA, 1996 (ACT NO.108 OF 1996)

The Constitution of South Africa (Act No 108 of 1996) is the cornerstone of democracy in South Africa and under Chapter 2 it outlines the Bill of Rights which includes Section 24 that states: Everyone has the right

a) to an environment that is not harmful to their health or well-being; and
b) to have the environment protected, for the benefit of present and future generations, through 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 a justifiable economic and social development.

Section 24 thus requires that all activities that may significantly affect the environment and require authorisation by law must be assessed prior to approval.

3.2. NATIONAL ENVIRONMENTAL MANAGEMENT ACT, 1998 (ACT NO.107 OF 1998)

The National Environmental Management Act aims to improve the quality of environmental decision-making by setting out principles for environmental management that apply to all government departments and organizations that may affect the environment. The IEM principles also aim to ensure that environmental impacts are considered before actions are taken or implemented and to ensure that there are adequate opportunities for public participation in decisions that may affect the environment. NEMA also creates a framework for facilitating the role of civil society in environmental governance.

The applicant is responsible for compliance with the provisions for Duty of Care and Remediation of Environmental Damage contained in section 28 of the National Environmental Management Act (Act 107 of 1998).

3.3. NATIONAL ENVIRONMENTAL MANAGEMENT: AIR QUALITY ACT, 2004 (ACT NO.39 OF 2004)

The main objective of the Air Quality Act (NEMAQA) is the protection of the environment and human health in a sustainable (economic, social and ecological) development framework, through reasonable measures of air pollution control. The prevailing legislation in the Republic of South Africa with regards to the air quality field is the National Environment Management: Air Quality Act (Act No. 39 of 2004) (NEM: AQA). The NEM: AQA repealed the Atmospheric Pollution Prevention Act (45 of 1965) (APPA).

According to NEM: AQA, the then Department of Environment Affairs and Tourism (now the Department of Environmental Affairs) (DEA), the provincial environmental departments and local authorities (district and local municipalities) are separately and jointly responsible for the implementation and enforcement of various aspects of NEM: AQA. Each of these spheres of government is obliged to appoint an air quality officer and to co-operate with each other and co-ordinate their activities through mechanisms provided for in the National Environment Management Act, 1998 (Act 107 of 1998) (NEMA).

The purpose of NEM: AQA is to set norms and standards that relate to:

- Institutional frameworks, roles and responsibilities;
- Air quality management planning;
- Air quality monitoring and information management;

- Air quality management measures; and
- General compliance and enforcement.

Amongst other things, it is intended that the setting of norms and standards will achieve the following:

- The protection, restoration and enhancement of air quality in South Africa;
- Increased public participation in the protection of air quality and improved public access to relevant and meaningful information about air quality; and
- The reduction of risks to human health and the prevention of the degradation of air quality.

A fundamental aspect of the new approach to the air quality regulation, as reflected in the NEM: AQA, is the establishment of National Ambient Air Quality Standards (NAAQS). These standards provide the goals for air quality management plans and also provide the benchmark by which the effectiveness of these management plans is measured. The NEM: AQA provides for the identification of priority pollutants and the setting of ambient standards with respect to these pollutants.

The Act ensures that air quality planning is integrated with existing activities. The implications of this are that plans that are required in terms of the NEMA must incorporate consideration of air quality. In addition, Integrated Development Plans (IDP's) developed by local and district municipalities, also have to take air quality into account.

The Act describes various regulatory tools that should be developed to ensure the implementation and enforcement of air quality management plans. These include:

- *Priority Areas*, which are air pollution 'hot spots';
- *Listed Activities and Minimum Emission Standards*[1], under Section 21 of the AQA which are 'problem' processes that require an Atmospheric Emission Licence (AEL) in order to operate;

1 Minimum Emission Standards are the highest emission standards at which a Listed Activity will be allowed to operate under normal working conditions. If a definition of the process operated on the plant is matching the process description under established Listed Activities, the plant operates a Listed Activity and it must then be in possession of an Atmospheric Emission Licence indicating the

- *Controlled Emitters*, which includes the setting of emission standards for 'classes' of emitters, such as motor vehicles, incinerators, etc., as well as controlled fuels;
- Control of Dust;
- Control of Noise; and
- Control of Odours.

In order to facilitate implementation of and compliance with the NEM: AQA, the Act provides for government to turn down AEL applications from applicants who have a problematic record of air quality management practices. It also provides for government to demand that 'problem' industries appoint qualified air quality practitioners.

The Act also deals with South Africa's international obligations in terms of air quality management. Provision is made for the control of processes impacting on South Africa's neighbours and the global atmosphere in general, as well as trans-boundary air pollution.

The Act further regulates the establishment of the National Framework for Air Quality Management (NFAQM). The 2007 framework was amended on the 29 November 2013. The Act as a whole is defined by the adoption of a comprehensive approach to the management of offences and penalties, which includes the provision of transitional arrangements. The Act provides for flexibility and proactive approach, so that permissible emission limits can be amended on a progressive basis in order to achieve set air quality standards. As a consequence, the NEM: AQA came into full effect only on 1 April 2010. Certain sections of the Act came into force on 11 September 2005, but the Minister excluded other sections until such time as local authorities had the capacity and skills to deal with the implementation of the legislation. Significantly, many of the excluded sections related to listed activities and licensing of listed activities. The excluded sections were brought into effect on the 31 March 2010, and the old APPA of 1965 was fully repealed on the same date.

specific Listed Activity(s) operated on the facility. Not only must the plant be in possession of an Atmospheric Emission Licence, it must also comply with the conditions within the licence to comply with NEM:AQA.

The NEM: AQA Act also required the Minister or the Member of Executive Council (MEC) to identify and publish activities which result in atmospheric emissions that require an Atmospheric Emission Licence before they can operate. On 31 March 2010 under GNR248 the list of activities which result in atmospheric emissions which may have a significant detrimental effect on the environment were published.1 April 2010 also marked the date when the new list of activities requiring Atmospheric Emissions Licenses to operate was promulgated and, with this, the levelling of the atmospheric emission “playing field” through the setting of minimum emissions standards for all these listed activities was implemented.

On 22 November 2013 the Minister repealed the listed activities promulgated on 31 March 2010 and introduced a new list of activities under GNR 893 promulgated on 22 November 2013. Government Notice 893 (GN893:2013) established and identified activities which result in atmospheric emissions for which an Atmospheric Emission Licence must be obtained before operation can take place.

GN893:2013 lists the ten main categories, each with its associated subcategories (more detailed description of the exact activities and minimum emission standards), for which an Atmospheric Emission Licence needs to be obtained. The main categories include:

- Combustion Installations
- Petroleum Industry
- Carbonization and Coal Gasification
- Metallurgical Industry
- Mineral Processing, Storage and Handling
- Organic Chemicals Industry
- Inorganic Chemicals Industry
- Disposal of Hazardous and General Waste
- Pulp and Paper Manufacturing Activities
- Animal Matter Processing.

The Notice further states that the minimum emission standards will be applicable to both permanently operating plants and for experimental (pilot) plants with a design capacity equivalent to the one of a listed activity. Minimum standards are applicable under normal working conditions, and any normal start-ups, maintenance, upset and shut-down conditions that exceed a period of 48 hours will be subject to Section 30 of the AQA, which deals with control of emergency accidents. Upset conditions means any temporary failure of air pollution control equipment or failure of a process to operate in a normal or usual manner that leads to an emission standard being exceeded. This list of activities has been amended and a revised version released in November of 2013.

Any new plant must comply with the new plant minimum emission standards as contained in Part 3 of the Notice (which gives detailed account of minimum emission standards) on the date of publication of the notice, which was 31 March 2010.

DEA has established the National Ambient Air Quality Standards for the criteria pollutants in the Government Notice - GN1210:2009 (Table 2).

Table 1 gives an overview of the established NAAQS, as well reference methods and compliance dates for criteria pollutants.

TABLE 1 NATIONAL AMBIENT AIR QUALITY STANDARDS

National Ambient Air Quality Standard for Sulphur Dioxide (SO_2)				
AVERAGING PERIOD	**LIMIT VALUE ($\mu g/m^3$)**	**LIMIT VALUE (ppb)**	**FREQUENCY OF EXCEEDANCE**	**COMPLIANCE DATE**
10 Minutes	500	191	526	Immediate
1 hour	350	134	88	Immediate
24 hours	125	48	4	Immediate
1 year	50	19	0	Immediate
The reference method for the analysis of SO_2 shall be ISO 6767.				

National Ambient Air Quality Standard for Nitrogen Dioxide (NO_2)				
AVERAGING PERIOD	**LIMIT VALUE ($\mu g/m^3$)**	**LIMIT VALUE (ppb)**	**FREQUENCY OF EXCEEDANCE**	**COMPLIANCE DATE**
1 hour	200	106	88	Immediate
1 year	40	21	0	Immediate
The reference method for the analysis of NO_2 shall be ISO 7996.				

National Ambient Air Quality Standard for Particulate Matter (PM_{10})			
AVERAGING PERIOD	**LIMIT VALUE ($\mu g/m^3$)**	**FREQUENCY OF EXCEEDANCE**	**COMPLIANCE DATE**

24 hour	75	4	1 January 2015
1 year	40	0	1 January 2015

The reference method for the determination of the PM_{10} fraction of suspended particulate matter shall be EN 12341.

National Ambient Air Quality Standard for Ozone (O_3)

AVERAGING PERIOD	LIMIT VALUE ($\mu g/m^3$)	LIMIT VALUE (ppb)	FREQUENCY OF EXCEEDANCE	COMPLIANCE DATE
8 hours (running)	120	61	11	Immediate

The reference method for the analysis of ozone shall be the UV photometric method as described in SANS 13964.

National Ambient Air Quality Standard for Benzene (C_6H_6)

AVERAGING PERIOD	LIMIT VALUE ($\mu g/m^3$)	LIMIT VALUE (ppb)	FREQUENCY OF EXCEEDANCE	COMPLIANCE DATE
1 year	5	1.6	0	1 January 2015

The reference methods for the sampling and analysis of benzene shall either be EPA compendium method TO-14 A or method TO-17.

National Ambient Air Quality Standard for Lead (Pb)

AVERAGING PERIOD	LIMIT VALUE ($\mu g/m^3$)	LIMIT VALUE (ppb)	FREQUENCY OF EXCEEDANCE	COMPLIANCE DATE
1 year	0.5		0	Immediate

The reference method for the analysis of lead shall be ISO 9855.

National Ambient Air Quality Standard for Carbon Monoxide (CO)

AVERAGING PERIOD	LIMIT VALUE (mg/m^3)	LIMIT VALUE (ppm)	FREQUENCY OF EXCEEDANCE	COMPLIANCE DATE
1 hour	30	26	88	Immediate
8 hour (calculated on 1 hourly averages)	10	8.7	11	Immediate

The reference method for analysis of CO shall be ISO 4224.

The Minister of Water and Environmental Affairs, in terms of section 9 (1) of the NEM: AQA established the National Ambient Air Quality Standard for particulate matter of aerodynamic diameter less than 2.5 micron metre ($PM_{2.5}$), published in GN R 486 in GG 35463 of 29 June 2012.

TABLE 2 NATIONAL AMBIENT AIR QUALITY STANDARDS FOR PM2.5

National Ambient Air Quality Standard for Particulate Matter ($PM_{2.5}$)			
AVERAGING PERIOD	**CONCENTRATION**	**FREQUENCY OF EXCEEDANCE**	**COMPLIANCE DATE**
24 hours	65 µg/m^3	4	Immediate – 31 December 2015
24 hours	40 µg/m^3	4	1 January 2016 – 31 December 2029
24 hours	25 µg/m^3	4	1 January 2030
1 year	25 µg/m^3	0	Immediate – 31 December 2015
1 year	20 µg/m^3	0	1 January 2016 – 31 December 2029
1 year	15 µg/m^3	0	1 January 2030
The reference method for the determination of the $PM_{2.5}$ fraction of suspended particulate matter shall be EN 14907.			

In line with NEM: AQA, the National Department of Environmental Affairs has published important National Dust Control Regulations in Government Notice 827 in Gazette 36974 on 1 November 2013.

Terms like target, action and alert thresholds were omitted. Another notable observation was the reduction of the permissible frequency from three to two incidences within a year. The standard actually adopted a more stringent approach than previously, and will require dedicated mitigation plans once it is in force. The National Dust fallout standard is given in the Table below.

TABLE 3 ACCEPTABLE DUST FALL RATES (USING ASTM D1739:1970 OR EQUIVALENT)

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

3.4. OCCUPATIONAL HEALTH AND SAFETY ACT, 1993 (ACT NO.85 OF 1993)

To provide for the health and safety of persons at work and for the health and safety of persons in connection with the use of plant and machinery; the protection of persons other than persons at work against hazards to health and safety arising out of or in connection with the activities of persons at work.

3.5. NATIONAL ENVIRONMENTAL MANAGEMENT: WASTE ACT, 2008 (ACT NO.59 OF 2008)

Provides for the specific waste management measures and the remediation of contaminated land.

4. REGIONAL OVERVIEW OF THE STUDY AREA

The section below outlines relevant baseline information on air quality and climate issues within the region

4.1. PROVINCIAL OVERVIEW

The Ehlanzeni District Municipality is comprised of 4 Local Municipalities which include;

- Nkomazi Local Municipality;
- Bushbuckridge Local Municipality;
- Mbombela Local Municipality;
- Thaba Chweu Local Municipality

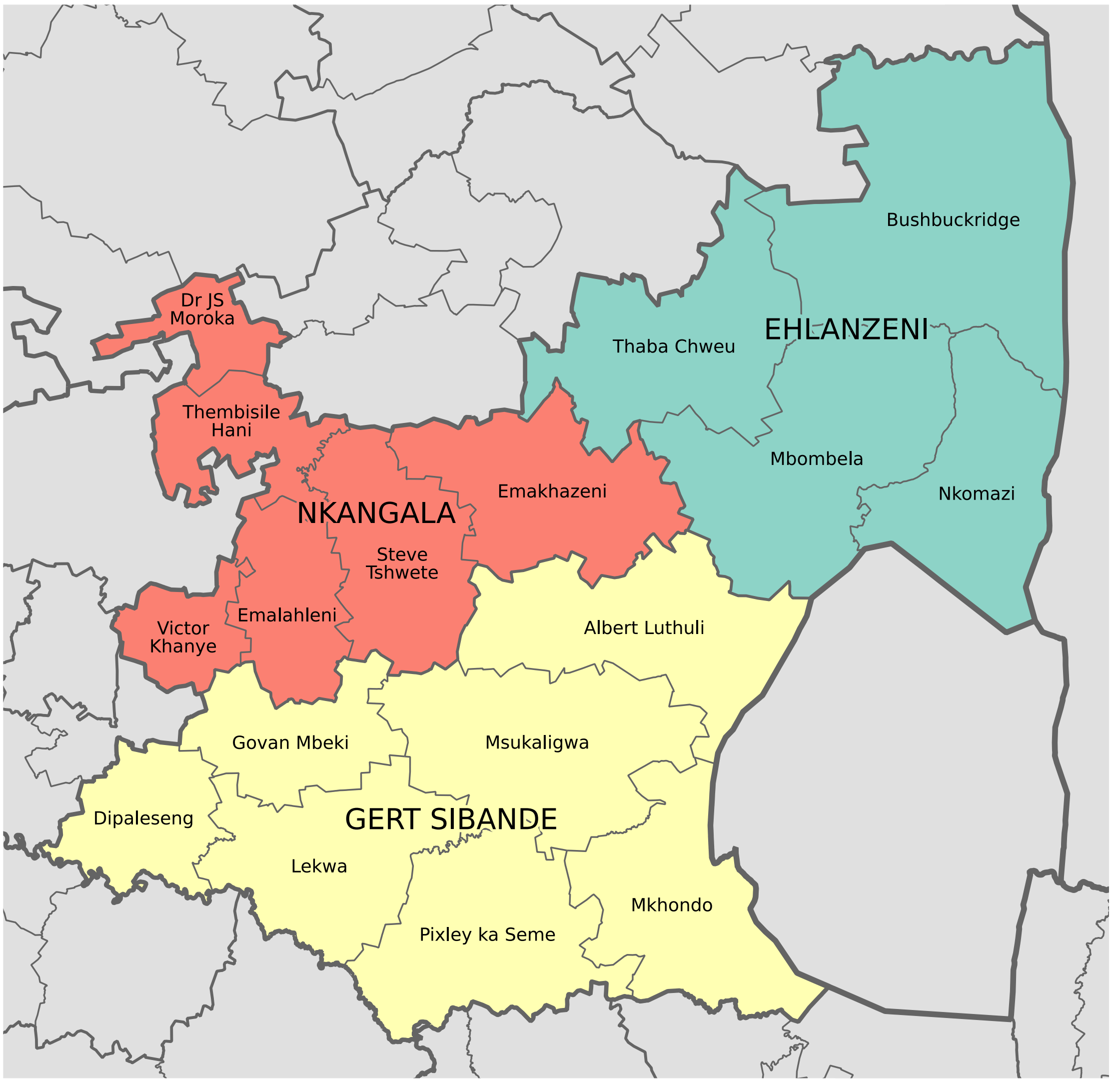

FIGURE 5 EHLANZENI DISTRICT MUNICIPALITY

The Ehlanzeni District Municipality (EDM) is one of the three districts in the Mpumalanga Province of South Africa. It is situated in the Northern Eastern part of the province and covers the entire Southern part of the renowned Kruger National Park.

Geographical Size

EDM covers a vast area of 27,895.47 km², which accounts for approximately 36.47% of the total estimated land size of Mpumalanga Province, which is 76,495 km². This makes EDM one of the larger districts in the province.

Bordering Countries

The district shares international borders with Mozambique to the east and Swaziland (now known as Eswatini) to the south. These borders provide opportunities for cross-border interactions and collaborations.

Neighbouring Districts

In addition to the international borders, EDM is also bordered by three other district municipalities within South Africa. These neighboring districts are Sekhukhune in the north, Nkangala in the west, and Gert Sibande in the south.

Local Municipalities

EDM is comprised of four local municipalities:

- Bushbuckridge
- City of Mbombela
- Nkomazi
- Thaba Chweu

Overall, EDM is strategically positioned in a diverse and ecologically significant region of Mpumalanga Province. With its rich natural resources, including the Southern part of the Kruger National Park, it has the potential to be a key player in sustainable development, tourism, and environmental conservation.

NKOMAZI LOCAL MUNICIPALITY

Nkomazi Local Municipality is a Category B municipality situated in the eastern part of the Ehlanzeni District, which is located in the Mpumalanga Province of South Africa. The municipality holds a strategic location, positioned between Swaziland (north of Swaziland) and Mozambique (east of Mozambique). It shares its borders with the Kruger National Park to the north and the City of Mbombela Local Municipality to the west.

Geographical Size

Nkomazi is the smallest of the four municipalities in the Ehlanzeni District, covering approximately 17% of the district's geographical area. The total land area of Nkomazi is approximately 4,785 km².

Transport Links

The municipality is well-connected with its neighboring countries and regions. It is linked to Swaziland through two provincial roads and to Mozambique by a railway line and the main national road, known as N4, which forms the Maputo Corridor. These transport connections play a crucial role in facilitating trade and transportation in the region.

Main Towns

Nkomazi Local Municipality is home to three main towns:

- Komatipoort
- Malelane
- Marloth Park

Economic Sectors

The local economy of Nkomazi revolves around three main sectors:

- Agriculture: The region is known for its agricultural activities, including crop farming and livestock production.
- Tourism: The proximity to the Kruger National Park and other natural attractions makes tourism an important contributor to the local economy.
- Mining: The area is also involved in mining activities, likely related to mineral resources found in the region.

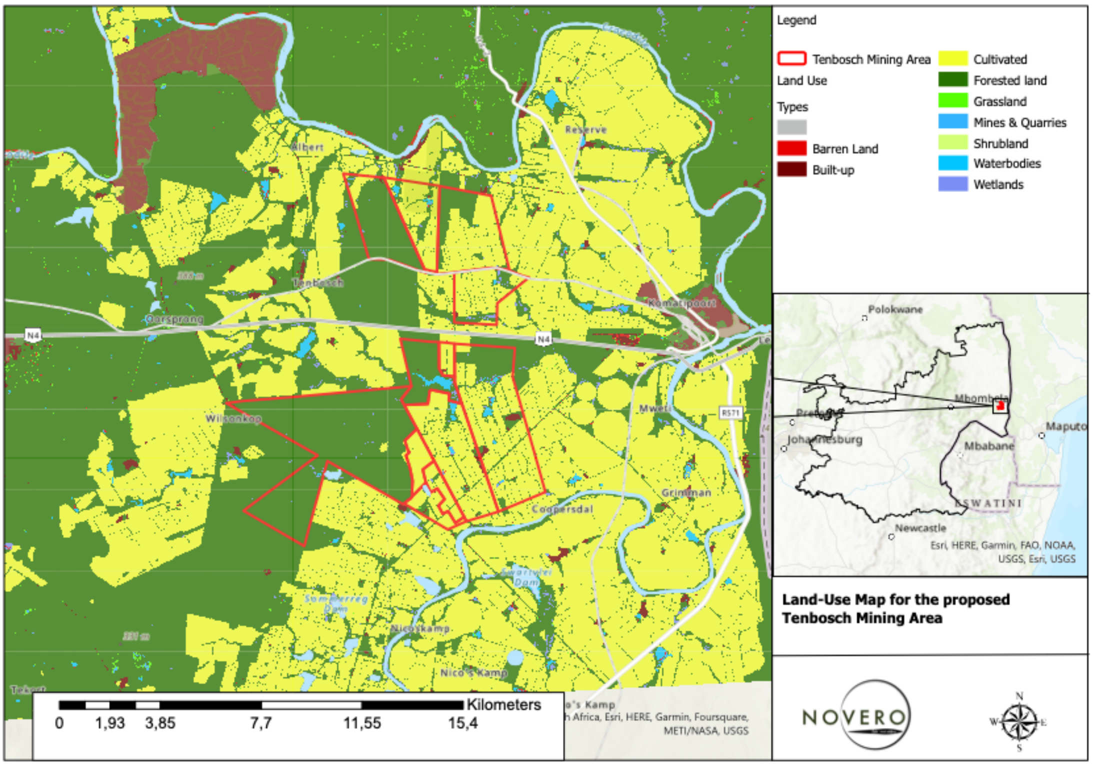

FIGURE 6 LAND USE MAP

As a Category B municipality, Nkomazi is responsible for delivering essential services to its residents, such as water, sanitation, waste management, and local infrastructure development. The municipality's strategic location and economic sectors provide opportunities for growth and development, with a focus on promoting sustainable tourism, agricultural productivity, and responsible mining practices.

Efforts to enhance the well-being of its inhabitants, attract investments, and create employment opportunities are likely to be part of the municipality's development plans. Furthermore, cooperation with neighbouring regions and countries plays a vital role in ensuring the socio-economic prosperity of Nkomazi Local Municipality.

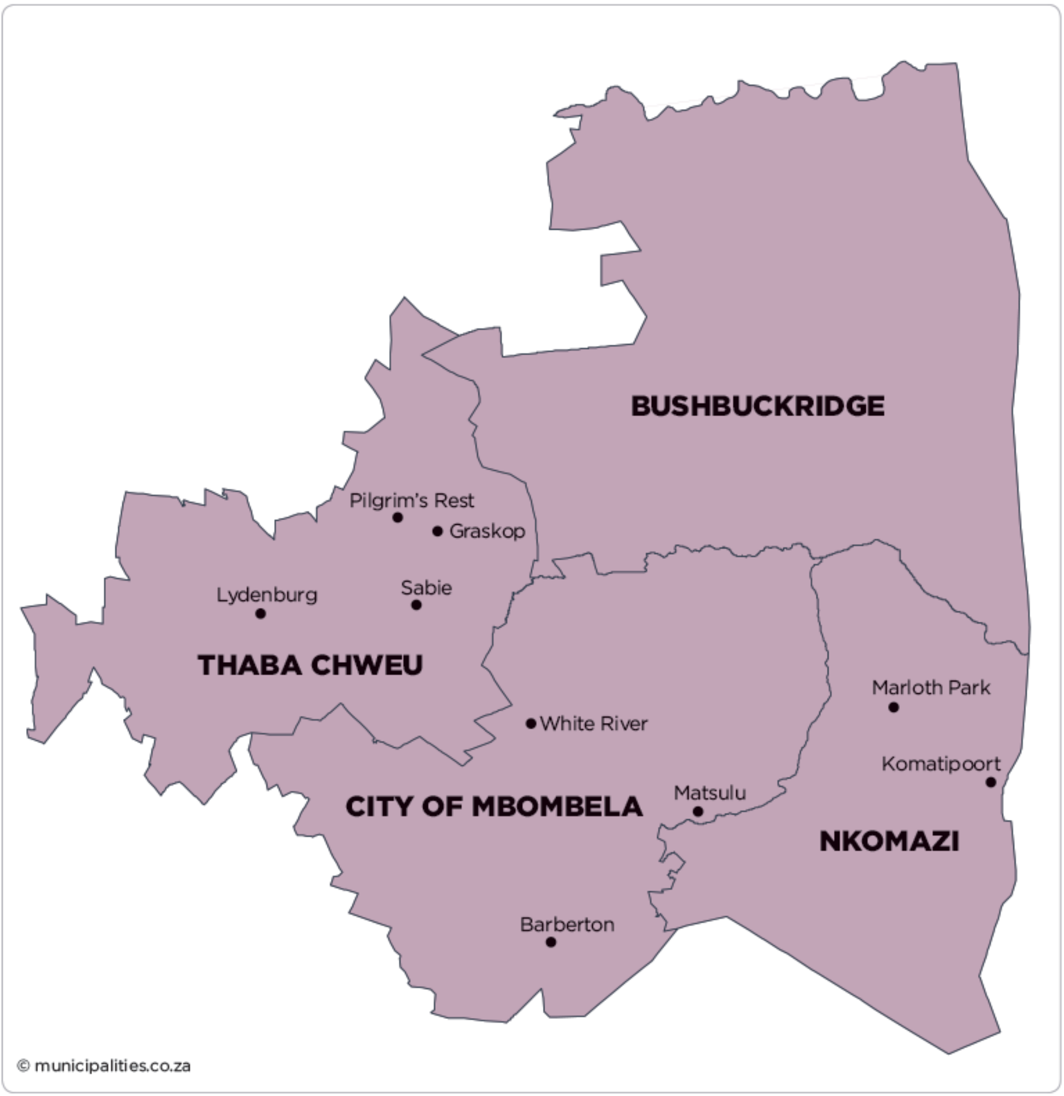

FIGURE 7 DISTRICT MAP (SOURCE : MUNICIPALITIES 2023)

4.2. REGIONAL CLIMATE

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

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

It is these climatic conditions and circulation movements that are responsible for the distribution and dispersion of air pollutants within and around the BPC project area, neighbouring provinces and countries bordering South Africa.

Furthermore, meteorological characteristics of a site govern the dispersion, transformation and eventual removal of pollutants from the atmosphere. The extent to which pollution will accumulate or disperse in the atmosphere is dependent on the degree of thermal and mechanical turbulence within the earth's boundary layer. Dispersion comprises vertical and horizontal components of motion. The vertical component is defined by the stability of the atmosphere and the depth of the surface mixing layer. The horizontal dispersion of pollution in the boundary layer is primarily a function of the wind field. The wind speed determines both the distance of downwind transport and the rate of dilution as a result of plume "stretching". The generation of mechanical turbulence is similarly a function of the wind speed, in combination with the surface roughness. The wind direction and the variability in wind direction, determine the general path pollutants will follow, and the extent of cross-wind spreading.

Pollution concentration levels fluctuate in response to changes in atmospheric stability, to concurrent variations in the mixing depth, and to shifts in the wind field. Spatial variations, and diurnal and seasonal changes, in the wind field and stability regime are functions of atmospheric processes operating at various temporal and spatial scales. Atmospheric processes at macro-scales and meso-scales therefore need to be taken into account in order to accurately parameterise the atmospheric dispersion potential of a particular area. Parameters that need to be taken into account in the characterisation of mesoscale ventilation potentials include wind speed, wind direction, extent of atmospheric turbulence, ambient air temperature and mixing depth (Pasquill, Smith 1983, Godish 1990).

4.3. CLIMATE AND METEOROLOGICAL OVERVIEW

The climatic conditions in this region vary greatly from west to east. The far western region is arid encompassing the eastern sides of the Kalahari Desert. The central region is predominately semi-arid while the eastern region is temperate. Ambient air quality in this region of South Africa is strongly influenced by regional atmospheric movements, together with local climatic and meteorological conditions. The most important of these atmospheric movement routes are the direct transport towards the Indian Ocean and the recirculation over the sub-continents.

Nkomazi Municipality, being located in the Mpumalanga Province of South Africa, experiences a subtropical climate. The climate in the region is characterized by hot summers and mild winters. The temperatures in Nkomazi can be quite high during the summer months (November to February), with average highs ranging from 30°C to 35°C. Winters (June to August) are generally milder, with average daytime temperatures ranging from 18°C to 25°C. Nighttime temperatures can drop significantly during the winter months.

Nkomazi experiences a distinct wet season and dry season. The wet season occurs during the summer months, with the highest rainfall typically observed from November to March. The region receives a significant amount of rainfall during this period, contributing to lush vegetation and agricultural activities. The dry season spans from April to October, with reduced precipitation and drier conditions prevailing.

The area can experience relatively high humidity levels, especially during the rainy season. The combination of high temperatures and humidity can make the summer months feel quite hot and sticky. Nkomazi does not experience strong prevailing winds throughout the year. However, during certain weather patterns, occasional gusts and breezes may occur. The region's climate is influenced by its proximity to the Indian Ocean and the Kruger National Park. Seasonal variations can impact wildlife migration patterns and vegetation growth, making it an important consideration for agriculture and tourism in the area.

Like many others, the region may face climate-related risks such as droughts, heavy rainfall leading to flooding, and extreme temperatures. Adequate water management and disaster preparedness are essential aspects of climate adaptation and mitigation for the region.

Komatipoort is approximately 15km away from Marloth Park. Weather information used was for komatipoort.

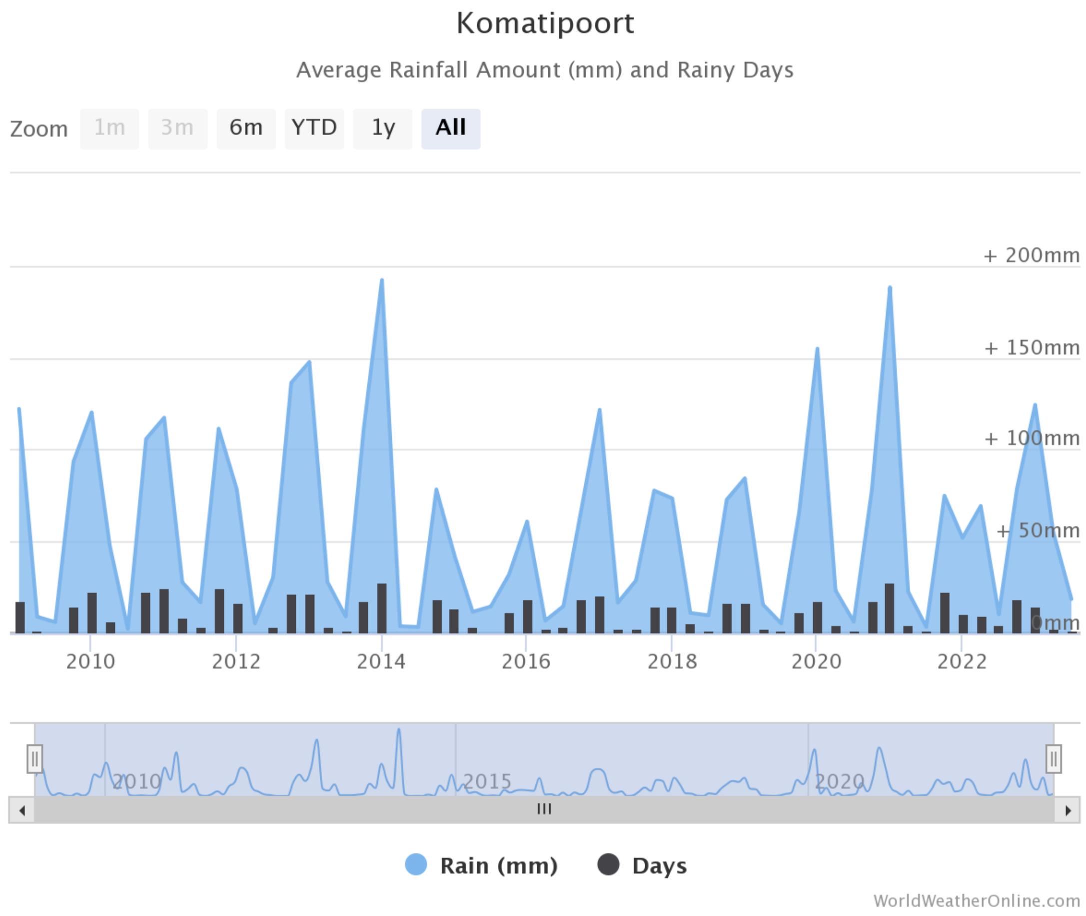

FIGURE 8 AVERAGE AREA RAINFALL (SOURCE : WORLD WEATHER ONLINE)

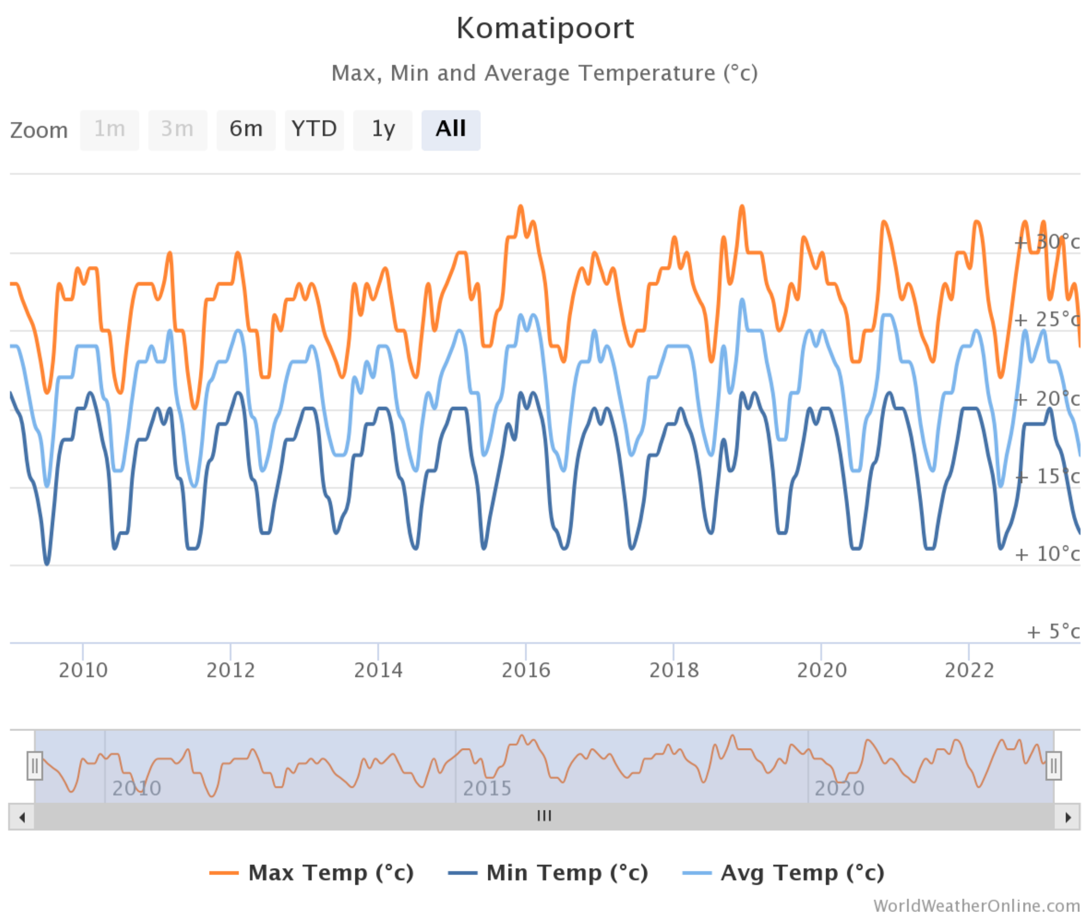

FIGURE 9 AVERAGE AREA TEMP (SOURCE : WORLDWEATHERONLINE)

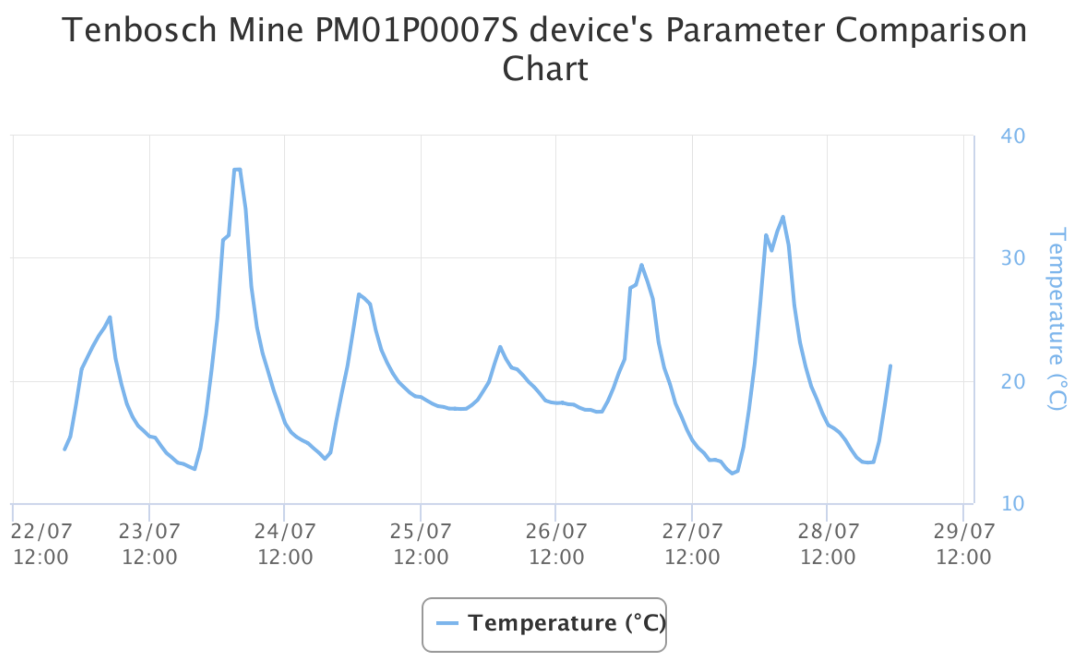

FIGURE 10 TEMPERATURE DATA (22/07/23 - 28/07/23)

There is a high variance between the minimum and maximum temperatures; daily maximums range from 20 to 36ºC and minimum from 10 to 13 ºC.

There is a reduced dispersion and a poorer ambient air quality during the winter period. Preston-Whyte and Tyson (1988) describe the atmospheric conditions in the winter months as highly unfavourable for the dispersion of atmospheric pollutants.

Dispersion of atmospheric pollutants is a function of the prevailing wind characteristics at any site. The vertical dispersion of pollution is largely a function of the wind field. The wind speed determines both the distance of downward transport and the rate of dilution of pollutants. The generation of mechanical turbulence is similarly a function of the wind speed, in combination with the surface roughness (Jacobson, 2005)

The amount of particulate matter (PM) generated by wind is highly dependent upon the wind speed. Below the wind speed threshold for a specific particle type, no PM is liberated, while above the threshold, PM liberation tends to increase with the wind speed. The amount of PM generated by wind is also dependent on the material's surface properties. This includes whether the material is crusted, the amount of non-erodible particles and the particle size distribution of the material (Fryrear *et al*., 1991). In terms of wind direction and speed in the area, the diagram below highlights the general trend.

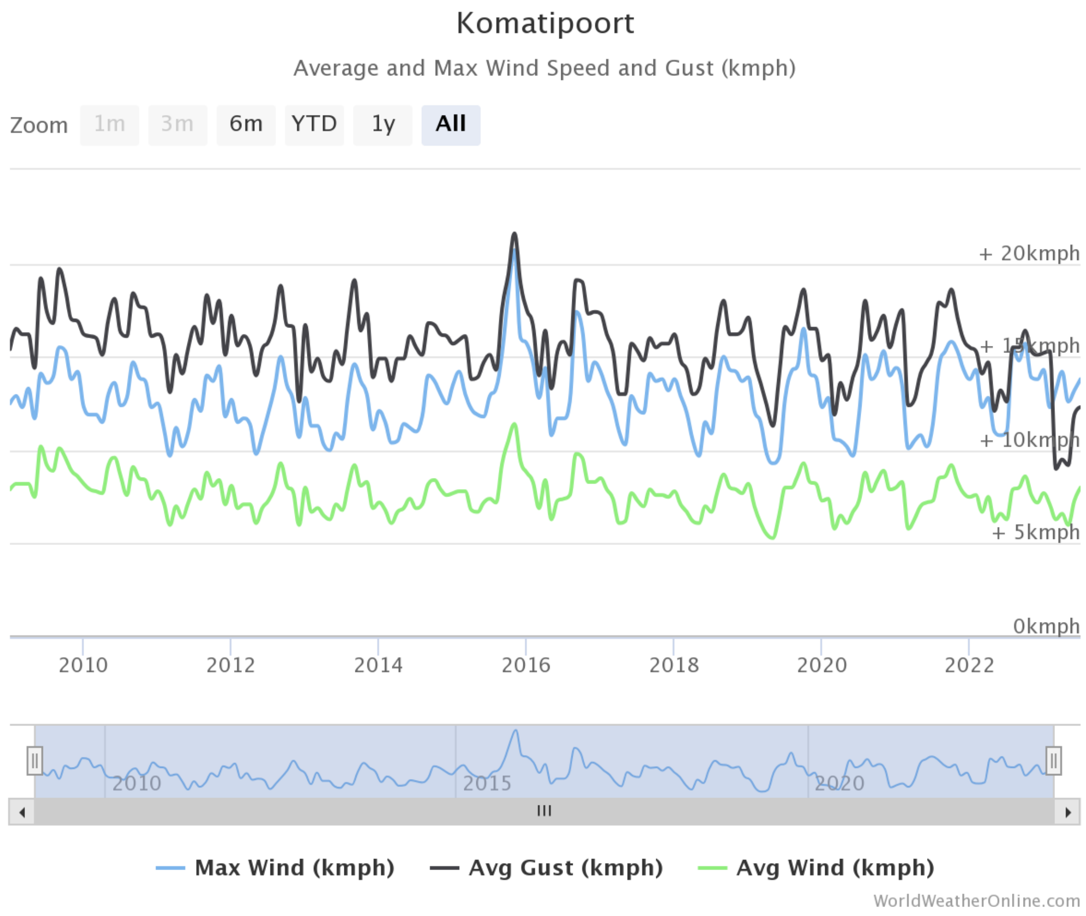

FIGURE 11 AVERAGE AREA WIND SPEED

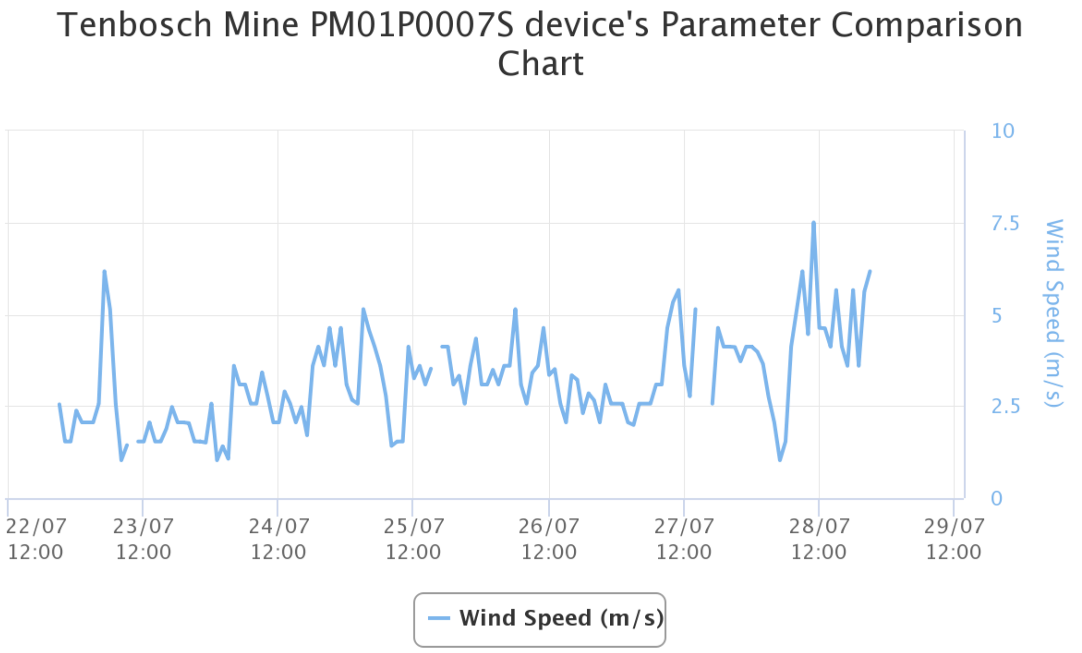

FIGURE 12 SITE SPECIFIC WIND DATA (22-28 JULY 2023)

Wind roses generally comprise of 16 spokes which represent the directions from which winds blew during the period. The colours reflect the different categories of wind speeds. The dotted circles provide information regarding the frequency of occurrence of wind speed and direction categories.

The predominant wind direction is from the west and South west.

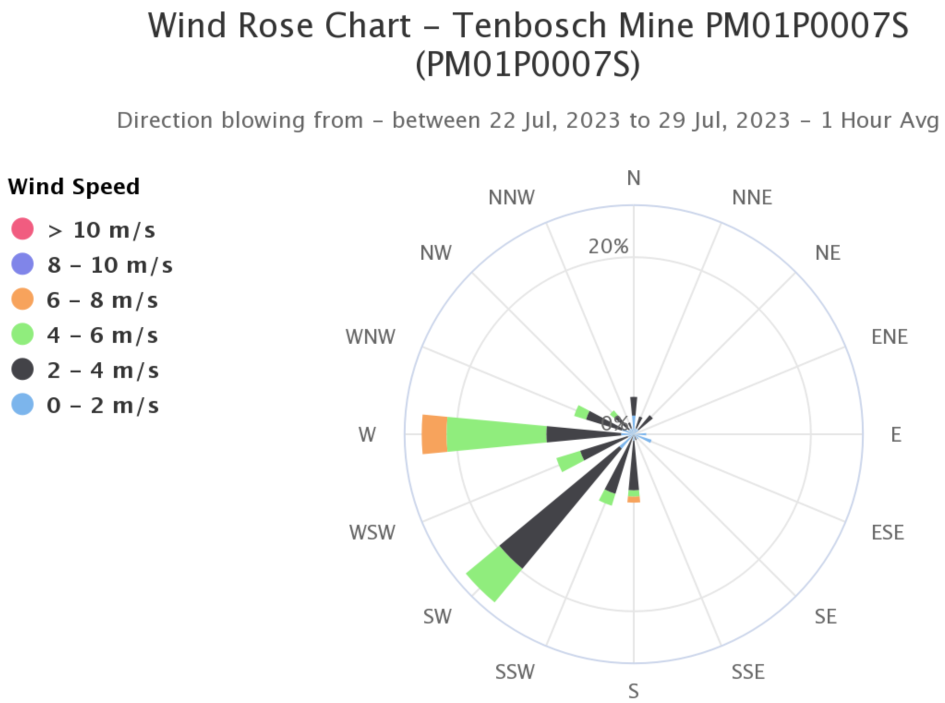

FIGURE 13 WIND ROSE FOR 7 DAYS ON SITE

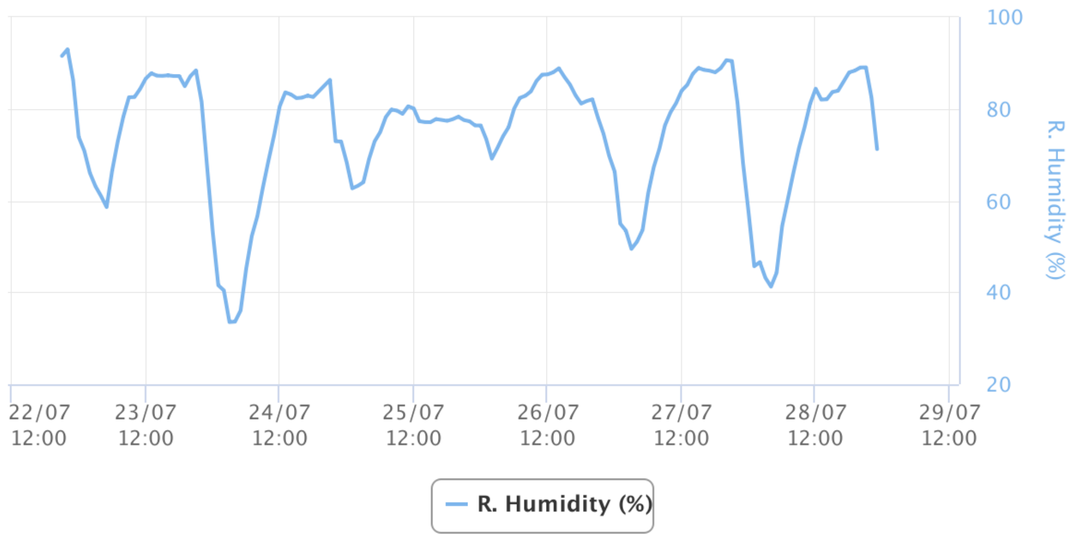

FIGURE 14 RELATIVE HUMIDITY _ FOOTPRINT AREA

4.4. TOPOGRAPHY

Marloth Park is situated in a region with varying elevations, and the topography is often described in meters above mean sea level (mamsl). The area's topography includes a range of elevations, including low-lying riverine areas along the Crocodile River and higher elevated sections with rocky outcrops or koppies.

The exact elevations within Marloth Park can vary, but some parts of the conservancy are around 150 meters above mean sea level, particularly in the riverine areas near the Crocodile River. Other areas within Marloth Park, such as the koppies and higher ground, can have elevations reaching up to 350 meters or more above mean sea level. The diverse topography of Marloth Park, with its mix of riverine areas, bushveld, koppies, and open grasslands, contributes to the unique and scenic landscape of the conservancy. This varied topography provides different habitats for wildlife.

Mining activities and surface infrastructure often have the potential to alter the topography. An alteration of the natural topography has the potential to present dangers to both animals and people as well as to alter natural systems such as water flow. The design of surface infrastructure should be such that any changes to topography result in stable topographic features that do not pose a significant risk to third parties. Impacts on the visual character of the area should be kept minimal and allow for effective surface water management.

FIGURE 15 FIGURE SHOWING THE KOPPIES AND FLAT TERRAIN WITHIN THE AREA

FIGURE 16 RIVERINE AREAS

FIGURE 17 CROCODILE RIVER

4.5. BOUNDARY LAYER PROPERTIES AND ATMOSPHERIC STABILITY

The atmospheric boundary layer constitutes the first few hundred metres of the atmosphere and is directly affected by the earth's surface. The earth's surface affects the boundary layer through the retardation of air flow created by frictional drag, created by the topography, or as a result of the heat and moisture exchanges that take place at the surface.

During the day, the atmospheric boundary layer is characterised by thermal heating of the earth's surface, converging heated air parcels and the generation of thermal turbulence, leading to the extension of the mixing layer to the lowest elevated inversion. These conditions are normally associated with elevated wind speeds, hence a greater dilution potential for the atmospheric pollutants.

During the night, radioactive flux divergence is dominant due to the loss of heat from the earth's surface. This usually results in the establishment of ground based temperature inversions and the erosion of the mixing layer. As a result, night-time is characterised by weak vertical mixing and the predominance of a stable layer. These conditions are normally associated with low wind speeds, hence less dilution potential.

The mixed layer ranges in depth from a few metres during night times to the base of the lowest elevated inversion during unstable, daytime conditions. Elevated inversions occur for a variety of reasons, however typically the lowest elevated inversion occurs at night during winter months when atmospheric stability is typically at its maximum. Atmospheric stability is frequently categorised into one of six stability classes. These are briefly described in Table 4.

The atmospheric boundary layer is normally unstable during the day as a result of the turbulence due to the sun's heating effect on the earth's surface. The thickness of this mixing layer depends predominantly on the extent of solar radiation, growing gradually from sunrise to reach a maximum at about 5-6 hours after sunrise. This situation is more pronounced during the winter months due to strong night-time inversions and a slower developing mixing layer. During the night a stable layer, with limited vertical mixing, exists. During windy and/or cloudy conditions, the atmosphere is normally neutral.

TABLE 4 ATMOSPHERIC STABILITY CATEGORIES

Designation	Stability Class	Atmospheric Condition
A	Very unstable	Calm wind, clear skies, hot daytime conditions
B	Moderately unstable	Clear skies, daytime conditions
C	Unstable	Moderate wind, slightly overcast daytime conditions
D	Neutral	High winds or cloudy days and nights
E	Stable	Moderate wind, slightly overcast night-time conditions
F & G	Very stable	Low winds, clear skies, cold night-time conditions

For elevated releases, the highest ground level concentrations would occur during unstable, daytime conditions. The wind speed resulting in the highest ground level concentration depends on the plume buoyancy. If the plume is considerably buoyant (high exit gas velocity and temperature) together with a low wind, the plume will reach the ground relatively far downwind. With stronger wind speeds, on the other hand, the plume may reach the ground closer, but due to the increased ventilation, it would be more diluted. A wind speed between these extremes would therefore be responsible for the highest ground level concentrations. In contrast, the highest concentrations for ground level, or near-ground level releases would occur during weak wind speeds and stable (night-time) atmospheric conditions.

4.6. AREA OF INFLUENCE – AIR QUALITY

The proposed Tenbosch Mine will have an influence at two levels from an air quality perspective. The first level has a narrow focus and can be referred to as the Area of Direct Influence (ADI). This is related directly to the project site. The second level refers to the broader Area of Indirect Influence (AII), which is around the project area. The areas of influence (both direct and indirect) are identified in accordance with the geographic environment in which the project is proposed to be undertaken, and on which it will potentially impact.

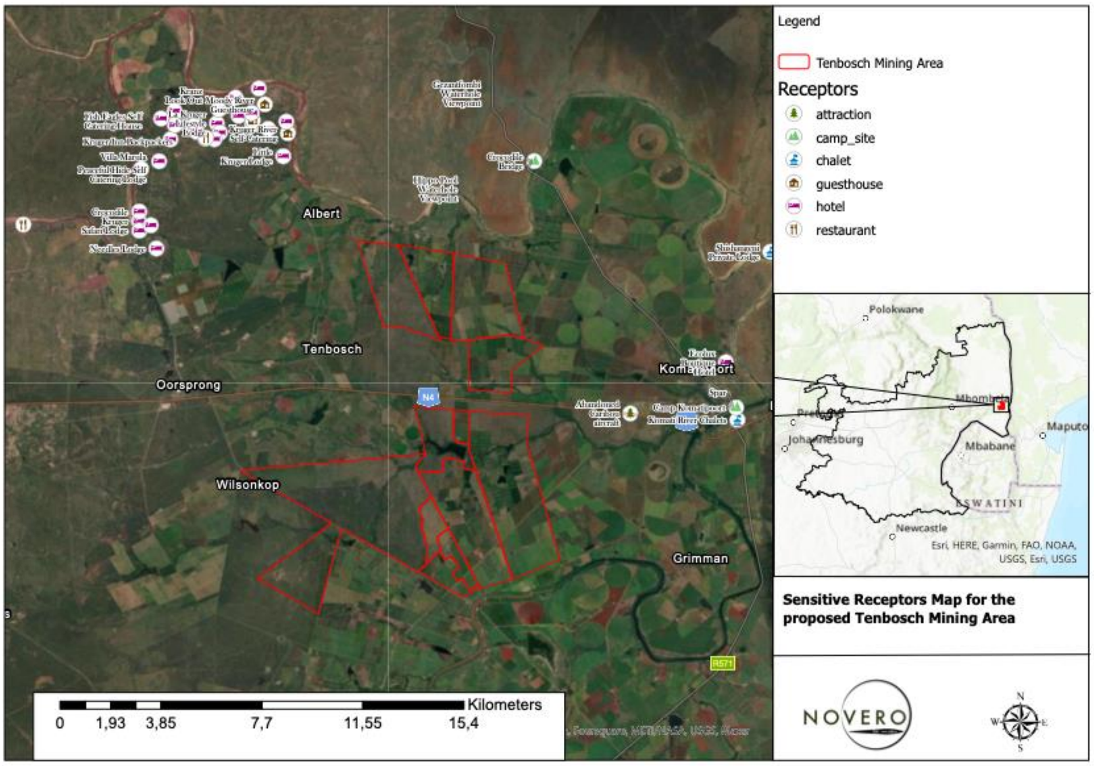

FIGURE 18 SENSITIVITY MAP

- **Area of Direct Influence -** The areas directly adjacent to mining project. This ADI has been selected as it encompasses the likely directly affected communities associated with the project and its location. This is based on the understanding of the local networks and dynamics, and reflects the communities and receptors which are likely to be directly affected by the project.
- **Area of Indirect Influence (AII)** – The **10** radius from the project centre has been selected since this is where the Tenbosch has predominantly indirect influence.

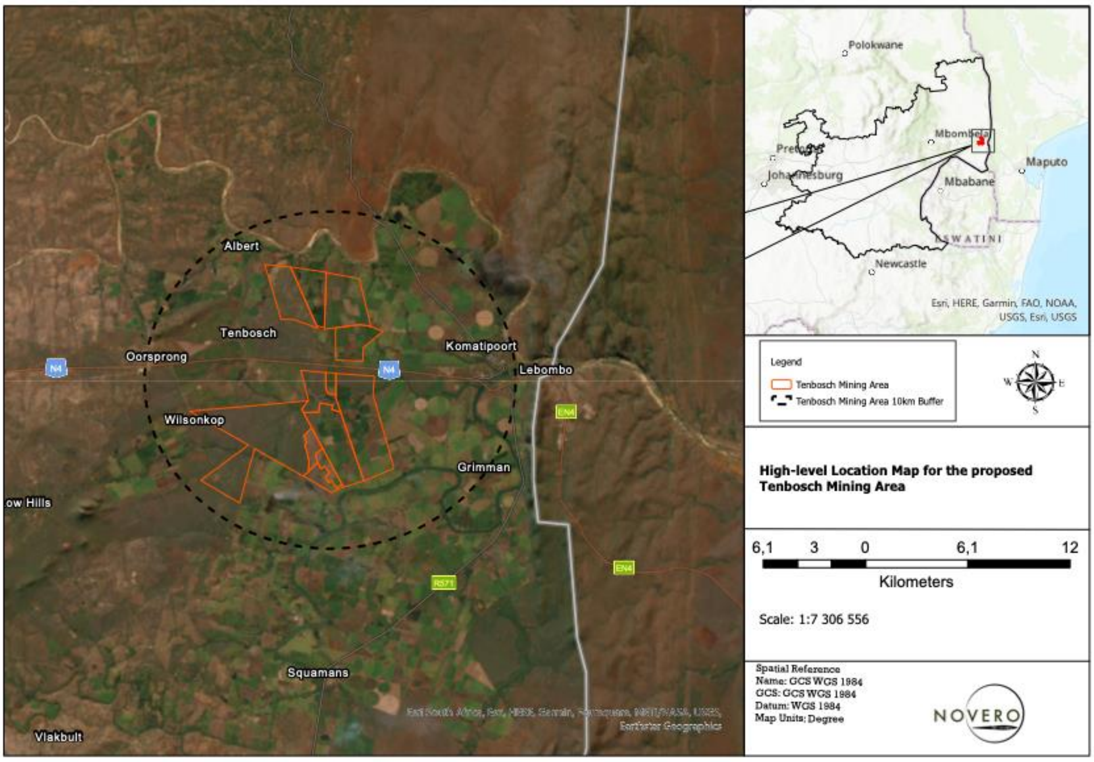

FIGURE 19 10KM BUFFER FROM CENTRE

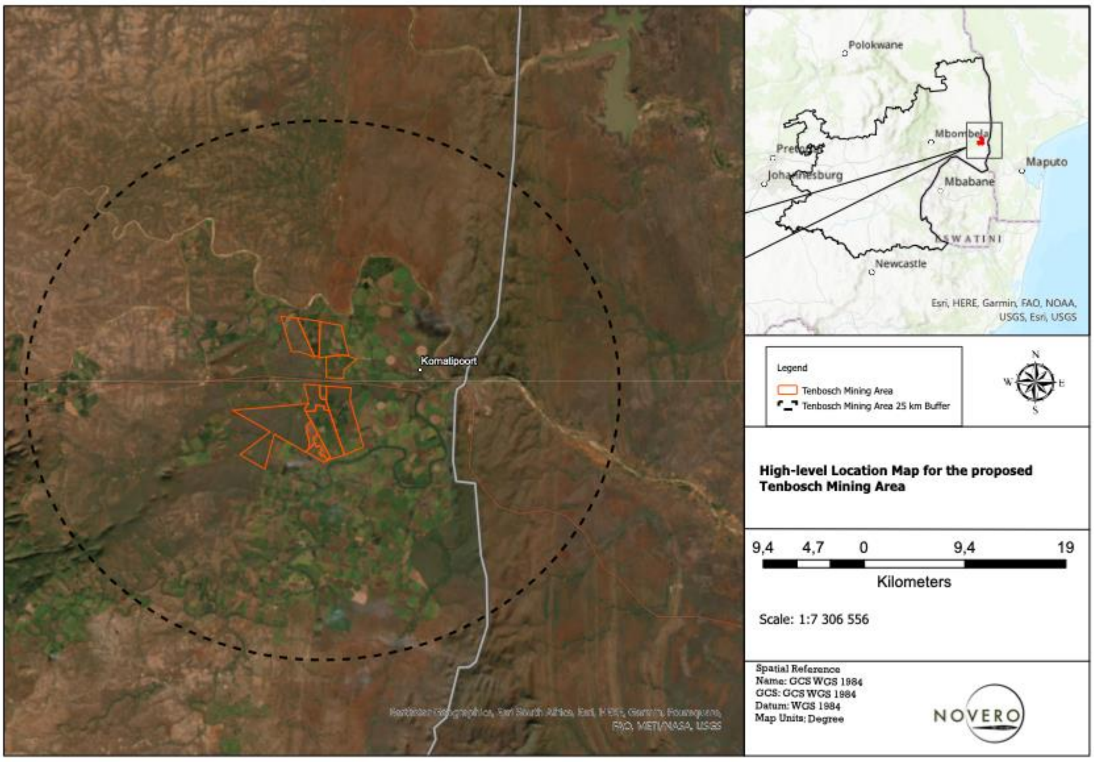

FIGURE 20 25KM BUFFER FROM FOOTPRINT CENTRE

Table 5 provides an overview of the key communities (and associated proximities) related to the proposed project within the ADI and the AII.

TABLE 5 OVERVIEW OF SETTLEMENTS RELATED TO THE PROPOSED PROJECT

Radius	Town/ Village	Population	Comments
0 – 10 km	Tenbosch, Grimman, Wilsonkop, Komatipoort, Albert, Oorsprong, Kruger National Park		There are several farms, Hotels, Lodges, heritage sites and shops

Source: According to information gathered through site visit

5. HEALTH IMPACTS OF POSSIBLE POLLUTANTS IN THE STUDY AREA

The section below outlines relevant baseline information on air quality and climate issues within the region

5.1. PARTICULATES

The primary pollutant of concern resulting from the mining development's operational phases will be particulate matter, which can exist in different forms such as total suspended particulates (TSP), PM10, or PM2.5. These particles can be categorized based on their aerodynamic properties into coarse particles (PM10) and fine particles (PM2.5). Fine particles encompass secondary aerosols like sulphates and nitrates, combustion particles, and recondensed organic and metal vapours, while coarse particles contain materials from the earth's crust and fugitive dust from roads and industries.

Regarding health effects, particulate air pollution has been linked to respiratory system complaints, according to the World Health Organization (WHO, 2000). The size of particles plays a crucial role in their impact on health as it determines where they deposit in the respiratory system. Fine particles, such as PM2.5, are considered more harmful to human health because they can penetrate deep into the lungs and are deposited in the smaller airways, including the respiratory bronchioles. In contrast, larger particles, like PM10, are less respirable and typically deposit in the extra thoracic part of the respiratory tract.

In summary, particulate matter, particularly PM10 and PM2.5, is the main pollutant of concern during the mining development's operational phases, and its health effects are primarily associated with respiratory issues, with fine particles being considered more harmful due to their deeper penetration into the respiratory system.
Particulate Matter (PM) is a common type of air pollution found in areas where people live, and it is primarily generated by human activities such as transportation, energy production, domestic fuel combustion, and various industries. Unlike some other pollutants, there is no established safe level of exposure to PM, and adverse health effects can occur even at low concentrations.

The health effects of PM are wide-ranging and can affect both the respiratory and cardiovascular systems in both children and adults. Both short-term and long-term exposures to PM have been linked to adverse health outcomes.

Young children, including unborn babies, are particularly vulnerable to the negative effects of PM exposure. The evidence strongly suggests a causal relationship between exposure to PM and deaths from respiratory diseases in the post-neonatal period (after the first 28 days of life). Additionally, PM exposure has been associated with adverse effects on lung development in children, leading to reversible deficits in lung function and chronically reduced lung growth rates, resulting in long-term lung function deficits.

Furthermore, there is sufficient evidence to establish a causal relationship between PM exposure and the aggravation of asthma, as well as the development of symptoms such as cough and bronchitis. Short-term variations in PM levels have been linked to daily mortality and hospital admissions, indicating the immediate impact of PM on health. Residents of more polluted areas have shown increased mortality from cardiovascular and respiratory diseases, as well as lung cancer.

In summary, particulate matter (PM) pollution is a significant health concern as it can lead to a wide range of adverse effects on the respiratory and cardiovascular systems, impacting both children and adults. There is no safe threshold for exposure to PM, and efforts to reduce PM emissions are crucial in mitigating its harmful effects on public health. The World Health Organization (WHO) revised its Air Quality Guidelines (AQG) for particulate matter (PM) in 2005, recognizing the adverse health effects even at low levels of exposure. The new AQG values for PM2.5 are set at 10 µg/m3 for the annual average and 25 µg/m3 for the 24-hour mean, which should not be exceeded for more than 3 days per year. For PM10, the corresponding guidelines are 20 µg/m3 for the annual average and 50 µg/m3 for the 24-hour mean.

Ambient PM10 concentrations are considered a good indicator of population exposure to outdoor PM sources. Numerous epidemiological studies conducted in Europe and other parts of the world have consistently shown adverse health effects associated with exposure to both PM10 and PM2.5 at concentrations currently observed in different regions.

In the late 1990s, WHO estimated that approximately 700 annual deaths from acute respiratory infections in children aged 0–4 years in the WHO European Region could be attributed to PM10 exposure alone. For adults, the population health effects of PM exposure are primarily associated with mortality linked to long-term exposure to fine PM (PM2.5). The health effects of PM exposure, both short-term and long-term, are significant and diverse, impacting various aspects of respiratory and cardiovascular health. The specific health effects associated with particulate matter exposure are summarized in Table 12, which is likely available in the WHO's report or guidelines on air quality.

Overall, WHO's revised AQG for PM and the evidence from various epidemiological studies emphasize the importance of reducing PM levels to safeguard public health and prevent adverse health outcomes associated with particulate matter pollution.

5.1.1. SHORT-TERM EXPOSURE

Recent studies have highlighted the association between short-term exposure to particulate matter and health effects, even at low concentrations of exposure. Earlier research conducted during the 1980s and early 1990s already examined the relationship between daily fluctuations in particulate matter and mortality at low levels of exposure.

For example, Pope et al. (1992) conducted a study in Utah Valley, analyzing daily mortality in relation to PM10 concentrations during the period 1985 - 1989. They observed effects on mortality at concentrations below 100 µg/m3, with a maximum daily average concentration recorded at 365 µg/m3. The study found that for every 100 µg/m3 increase in the 24-hour average PM10 concentration, there was a 13% increase in total daily mortality. Similarly, Schwartz (1993) conducted research in Birmingham, where daily PM10 concentrations reached 163 µg/m3. They also observed an increase in daily mortality associated with higher PM10 concentrations, with a higher relative risk for chronic lung disease and cardiovascular deaths compared to deaths from other causes.

It is important to note that in the past, daily particulate concentrations were much higher, often ranging between 100 – 1000 µg/m3. In more recent times, daily concentrations have decreased significantly and are typically in the range of 10 – 100 µg/m3. Despite the lower concentrations, recent studies still indicate health effects even at these lower levels of exposure. The exposure-response relationship for particulate matter can be described as curvilinear, meaning that the relationship between exposure and health effects is not linear but rather exhibits diminishing returns. In other words, small absolute changes in exposure at the low end of the concentration curve can have similar effects on mortality as larger absolute changes at the high end.

In summary, recent studies have reinforced the understanding that short-term exposure to particulate matter, even at lower concentrations, can have adverse health effects. The reduction in daily particulate concentrations over time has not eliminated the association between exposure and health impacts, indicating the continued importance of mitigating particulate matter pollution for public health reasons.

Short-term exposure to particulate matter has been linked to various morbidity effects, which include increased lower respiratory symptoms, medication usage, and small reductions in lung function.

In a study conducted by Pope and Dockery (1992) on panels of children in Utah Valley during the winter period of 1990 – 1991, daily PM10 concentrations ranged from 7 to 251 µg/m3. They found that as PM10 concentrations increased, Peak Expiratory Flow (PEF) decreased, and respiratory symptoms increased. This suggests that short-term exposure to higher levels of PM10 negatively impacted lung function and respiratory health in the children studied. In another study by Pope and Kanner (1993) in Salt Lake City, lung function data obtained from smokers with mild to moderate chronic obstructive pulmonary disease (COPD) was analyzed. The study estimated that for each 100 µg/m3 increase in the daily PM10 average, there was a 2% decline in Forced Expiratory Volume over one second (FEV1). This decline in FEV1 indicates impaired lung function due to short-term exposure to higher levels of PM10.

These findings indicate that short-term exposure to particulate matter, even at concentrations that are currently observed in many regions, can have noticeable and detrimental effects on respiratory health. The studies provide evidence of the immediate impact of particulate matter pollution on lung function and respiratory symptoms, particularly in vulnerable populations such as children and individuals with pre-existing respiratory conditions like COPD.

Overall, these research findings underscore the importance of air quality management and pollution control measures to minimize short-term exposure to particulate matter and protect public health, especially for those at higher risk of respiratory issues.

TABLE 6 SHORT-TERM AND LONG-TERM HEALTH EFFECTS ASSOCIATED WITH EXPOSURE TO PM (WHO 2004)

Pollutant	Short-term exposure	Long-term exposure
Particulate matter	• Lung inflammatory reactions • Respiratory symptoms • Adverse effects on the cardiovascular system • Increase in medication usage • Increase in hospital admissions • Increase in mortality	• Increase in lower respiratory symptoms • Reduction in lung function in children • Increase in chronic obstructive pulmonary disease • Reduction in lung function in adults • Reduction in life expectancy

5.1.2. LONG-TERM EXPOSURE

Long-term exposure to low concentrations of particulate matter, even as low as ~10 µg/m3, has been associated with various adverse health effects, including mortality and chronic respiratory issues, according to the World Health

Organization (WHO, 2000). The chronic effects of long-term exposure to particulates include increased rates of bronchitis and reduced lung function. Several studies have indicated a significant association between lung function and chronic respiratory diseases and airborne particles. Older studies by Chestnut et al. (1991) revealed that Forced Vital Capacity (FVC) decreases as the annual average particulate levels increase, with an apparent threshold at 60 µg/m3. This means that long-term exposure to particulate matter can lead to a decline in lung function, particularly when exposure reaches higher concentrations.

Additionally, Schwartz (1993) investigated chronic respiratory disease data and found that the risk of chronic bronchitis increased with rising particulate concentrations, and no apparent threshold was observed. This indicates that even at low concentrations of particulate matter, there can be a significant impact on the prevalence of chronic respiratory conditions.

However, there have been relatively few studies documenting the morbidity effects of long-term exposure to particulates. Recently, the Harvard Six Cities Study examined the health outcomes of children exposed to increasing concentrations of particulate matter, sulphate, and hydrogen ions. The study showed that respiratory illness rates increased among children as particulate concentrations rose. Relative risk estimates indicated an 11% increase in cough and bronchitis rates for every 10 µg/m3 increase in the annual average particulate concentrations.

These findings suggest that even long-term exposure to low concentrations of particulate matter can have adverse effects on respiratory health, including chronic respiratory diseases and reduced lung function. Therefore, measures to reduce particulate matter pollution and maintain air quality at acceptable levels are essential for protecting public health and minimizing the burden of respiratory illnesses in affected populations.

5.2. NITROGEN OXIDES (NOX)

Breathing in elevated levels of nitrogen dioxide (NO_2) can lead to various respiratory problems. One of the main effects of NO_2 is inflammation of the lining of the lungs, which can have several negative consequences for respiratory health.

NO_2 exposure can reduce the body's immunity to lung infections, making individuals more susceptible to respiratory illnesses. Common symptoms of breathing in higher levels of NO_2 include wheezing, coughing, and increased susceptibility to colds, flu, and bronchitis. For individuals with asthma, increased levels of nitrogen dioxide can be particularly problematic. It can trigger more frequent and more severe asthma attacks, making it difficult to manage the condition effectively. Children with asthma are especially vulnerable to the adverse effects of NO_2 exposure, as their developing respiratory systems can be more sensitive to air pollution. Additionally, older people with heart disease may also face increased risks from NO_2 exposure, as it can exacerbate their existing heart and respiratory conditions.

Given the respiratory and immune system impacts of nitrogen dioxide, it is crucial to control and minimize exposure to this air pollutant, especially for vulnerable populations. Regulatory efforts to reduce nitrogen dioxide emissions from various sources, such as vehicles and industrial facilities, are essential to protect public health and improve air quality. Additionally, individuals can take preventive measures, such as avoiding outdoor activities during peak pollution times, to reduce their exposure to NO_2 and other harmful pollutants.

5.3. SULPHUR DIOXIDE (SO_2)

Short-term exposure to sulfur dioxide (SO_2) can have adverse effects on the human respiratory system, causing breathing difficulties. Individuals with asthma, especially children, are particularly sensitive to the respiratory effects of SO_2 exposure. SO_2 emissions not only directly impact air quality but also contribute to the formation of other sulfur oxides (SO_x) in the atmosphere.

These SO_x can further react with other compounds in the air, leading to the formation of small particles. These particles are a significant contributor to particulate matter (PM) pollution.

The small particles formed from the reaction of SO_x and other compounds have the potential to penetrate deeply into the lungs when inhaled. If present in sufficient quantities, these particles can contribute to various health problems. To sum up, short-term exposure to SO_2 can harm respiratory health and make breathing difficult, with individuals suffering from asthma being particularly vulnerable. Moreover, the formation of small particles resulting from SO_x reactions contributes to particulate matter pollution, which can further impact respiratory health when these particles are inhaled into the lungs.

Carbon Monoxide (CO)

Breathing air with a high concentration of carbon monoxide (CO) can significantly reduce the amount of oxygen that can be transported in the bloodstream to critical organs like the heart and brain. At very high levels of CO, which can occur indoors or in enclosed environments with poor ventilation, individuals may experience symptoms such as dizziness, confusion, unconsciousness, and in severe cases, it can lead to death.

Although very high levels of CO are not likely to occur outdoors, elevated CO levels in outdoor air can still be a concern, particularly for individuals with certain types of heart disease. People with pre-existing heart conditions already have a reduced ability to supply oxygenated blood to their hearts, especially in situations where the heart requires more oxygen than usual, such as during exercise or times of increased stress. As a result, they are particularly vulnerable to the effects of CO when exposed to elevated levels.
In these situations, short-term exposure to elevated CO may lead to reduced oxygen supply to the heart, resulting in chest pain, also known as angina. This is a critical concern for individuals with heart disease as reduced oxygen to the heart can exacerbate their condition and lead to serious health complications.

Given the potential adverse effects of elevated CO levels on cardiovascular health, it is essential for individuals with heart conditions to be cautious when exposed to environments with high CO levels. Additionally, efforts to minimize CO emissions from vehicles, industrial processes, and indoor sources can help prevent harmful exposure and protect public health.

6. EMISSIONS INVENTORY

The Establishment of an emissions inventory forms the basis for any air quality assessment. Air pollution emissions may typically be obtained using actual sampling at the point of emission, or estimating it from mass and energy balances or emission factors which have been established at other, similar operations.

6.1. EMISSION CHARACTERISATION

The description of environmental issues addressed in this study relate solely to air quality impacts associated with the construction and operation of the proposed changes to the Tenbosch Mine Footprint in Marloth Park. Direct impacts will result from the construction phase of the project through the emission of dust fallout and airborne particulates. Dust and particulates will originate mainly from earth moving activities (scraping, compacting, excavation, grading), construction of the new mine infrastructure, movement of construction vehicles and back-fill operations. Dust emissions during decommissioning (i.e. removal) activities will emanate from the demolition of the mine infrastructure, earth moving activities (scraping, compacting, excavation, grading), movement of construction vehicles and back-fill operations. During windy conditions, the dust and particulates could potentially have negative impacts beyond the construction site. Contractors and site agents may be required to adopt dust control measures to cut down dust emissions to an acceptable level while carrying out construction works.

The quantity of dust produced is dependent on the magnitude of construction activities and the quantity of earth moved. The emission of dust and particulates and their associated air quality impacts will be handled qualitatively.

6.2. SOURCES OF EMISSIONS

There are various sources of emissions anticipated from the proposed coal mine which range from the proposed construction, operational and decommissioning phases. Typical emissions from the coal mine include:

- Carbon monoxide from moving vehicles and equipment
- Inhalable particulates, with aerodynamic diameters less than or equal to 10 micron (PM_{10}) and $PM_{2.5}$ from all mining sources;
- TSP from all mining sources.
- Sulphur dioxide from moving vehicles, equipment and combustion activities
- Nitrogen oxides from moving vehicles and equipment

An emissions inventory has been established comprising emissions for the different activities associated with the Tenbosch operations.

6.2.1. MATERIAL HANDLING OPERATIONS

Material handling focuses on the loading and offloading of ore – tipping, and storage / conveyors. These emissions depend on various factors such as wind speed, wind direction and precipitation. The higher the moisture content of the material, the less fugitive dust will be released during the process.

6.2.2. VEHICLE ACTIVITY ON HAUL ROADS

For haulage of waste and ore material from the Tenbosch operation, particulate vehicles i.e. 25 tonne trucks and above will be assumed.

6.2.3. WIND EROSION FROM ORE STOCKPILES

Various stockpiles release dust fallout, PM_{10} and $PM_{2.5}$.

6.2.4. FUEL STORAGE TANKS

It is anticipated that the site will also construct fuel storage tanks for their vehicles and mining equipment. VOC emissions from storage tanks that contain organic liquids, especially highly volatile liquids, occur because of evaporative losses of the liquid during its storage and as a result of changes in the liquid level. The emission rates are dependent on whether the tank is of fixed (solid) roof or floating roof design. The two significant types of emissions from fixed roof tanks are breathing and working losses. Breathing loss is the expulsion of vapour from tanks through vapour expansion and contraction, which is the result of changes in temperature and barometric pressure. This loss occurs without any change in liquid level in the tank. The loss from filling and emptying the tank is called working loss. Emissions during filling operations are as a result of an increase in the liquid level in the tank. As the liquid level increases, the pressure inside the tank exceeds the relief pressure and vapours are expelled from the tank. The total emissions from floating roof tanks are the sum of breathing losses and withdrawal losses. Withdrawal losses occur as the liquid level, and thus the floating roof, is lowered. Some liquid remains on the inner tank wall surface and evaporates. Standing storage loss from floating roof tanks include rim seal and deck fitting losses. Other potential standing storage loss mechanisms include breathing losses as a result of temperature and pressure changes.

7. METHODOLOGY, RESULTS AND DISCUSSION

7.1. BASELINE CHARACTERISATION

During the period 22 July, 2023 and 28 July, 2023, on-site studies were conducted in order to establish baseline information for the proposed mining project. An Oizom Polludrone air quality monitoring device was used to monitor the following parameters;

- Carbon Monoxide (CO)
- Nitrogen Oxide (NO)

- Nitrogen Dioxide (NO_2)
- Sulphur Dioxide (SO_2)
- Ozone (O_3)
- $PM_{2.5}$
- PM_{10}

7.2. CARBON MONOXIDE (CO)

Figure 21,22 and 23 indicates the levels of CO in the area during the winter months on July 2023. The CO levels range between 0.01 mg/m^3 and 0.2 mg/m^3 for the 1 hour averages and not exceeding 0.3 mg/m^3 for the 8 hourly average.

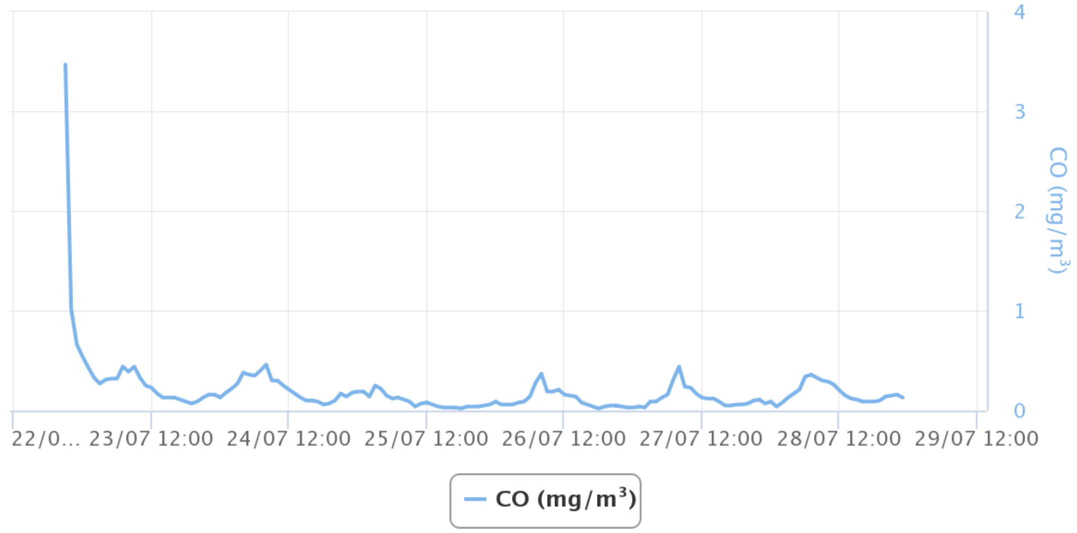

FIGURE 21 CO GRAPH FOR PROJECT AREA (1 HOUR AVERAGES)

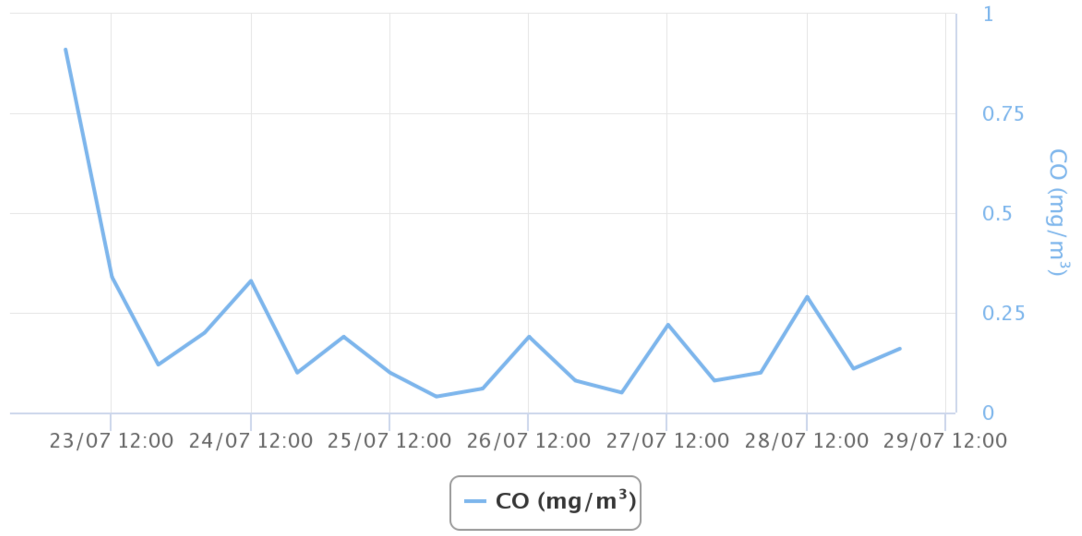

FIGURE 22 CO GRAPH FOR THE PROJECT AREA (8 HOUR AVERAGES)

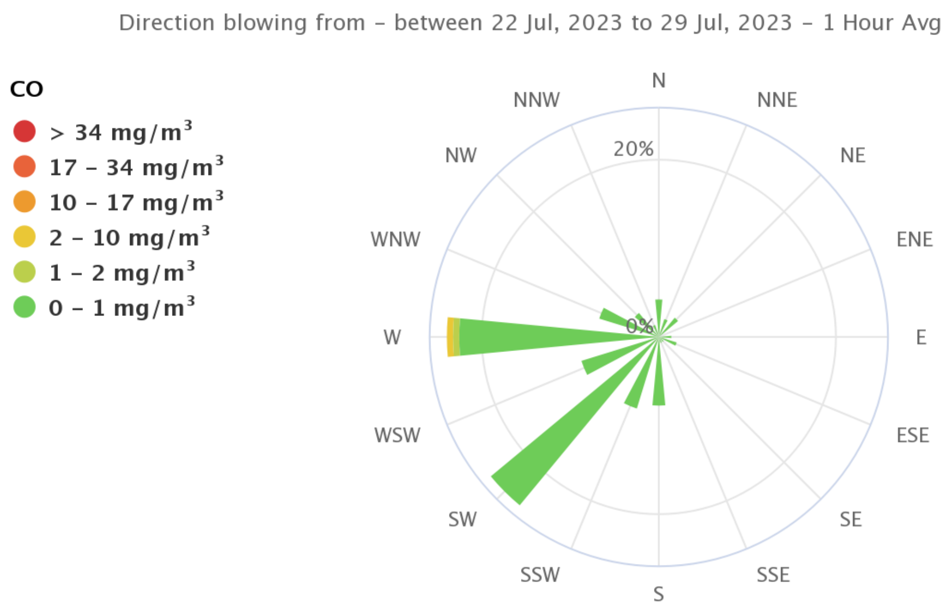

FIGURE 23 CO POLLUTION ROSE (1 HOUR AVERAGE)

7.3. (SO_2)DUST DEPOSITION RESULTS

Figure 24 & 25 indicates the levels of SO_2 in the area during the winter months on July 2023. The SO_2 levels range between 0 µg/m^3 and 380 µg/m^3.

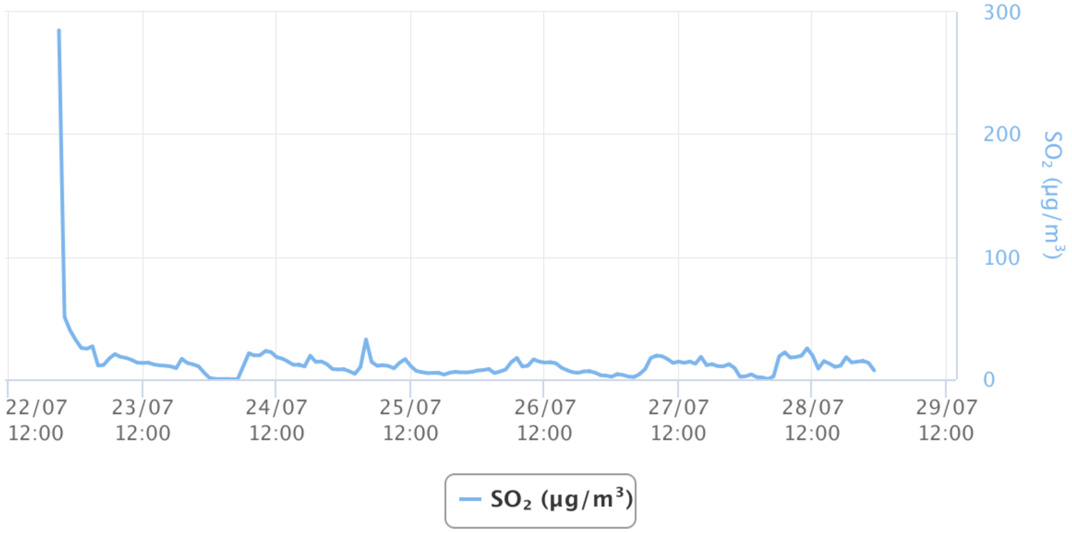

FIGURE 24 SO2 24 HOURLY AVERAGE _ FOOTPRINT AREA

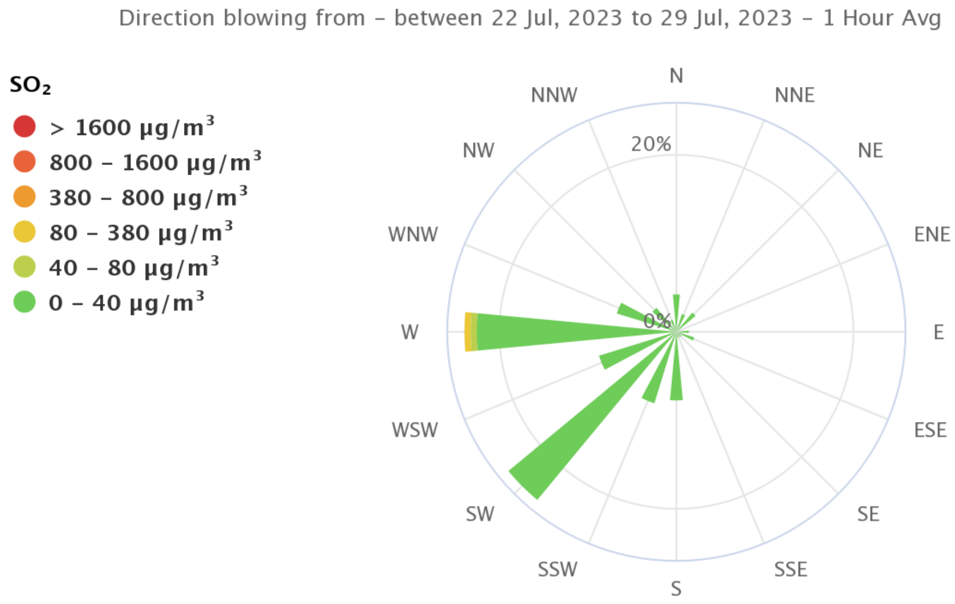

FIGURE 25 SO2 POLLUTION ROSE (1 HOURLY AVERAGE)

7.4. (NO2)

Figure 26 - 28 indicates the levels of NO2 in the area during the winter months on July 2023. The NO2 levels range between 40 µg/m^3 and 90 µg/m^3 for hourly average and below 100 ppb for 24 hourly averages.

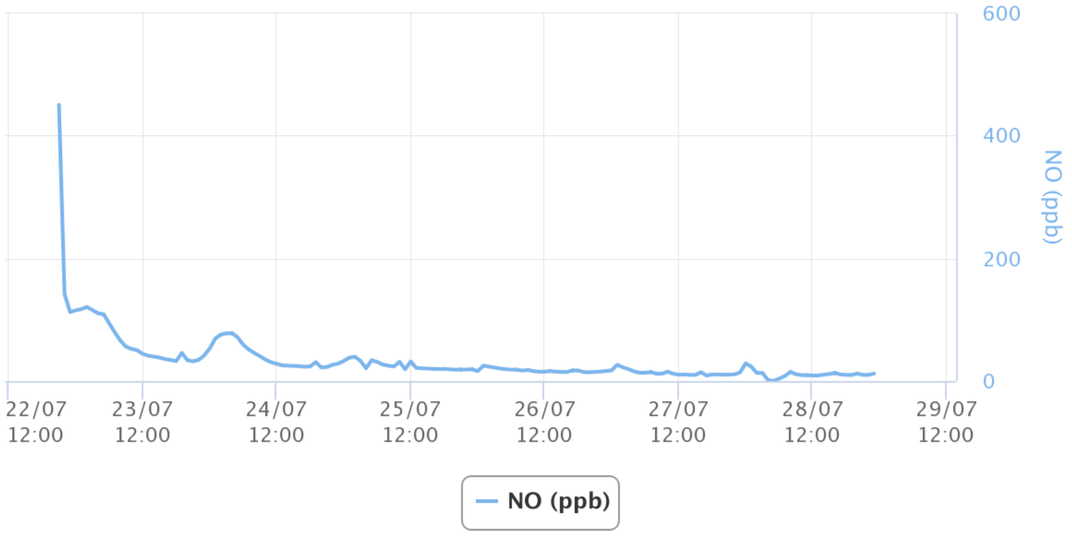

FIGURE 26 NO2 24 HOURLY AVERAGE _ FOOTPRINT AREA

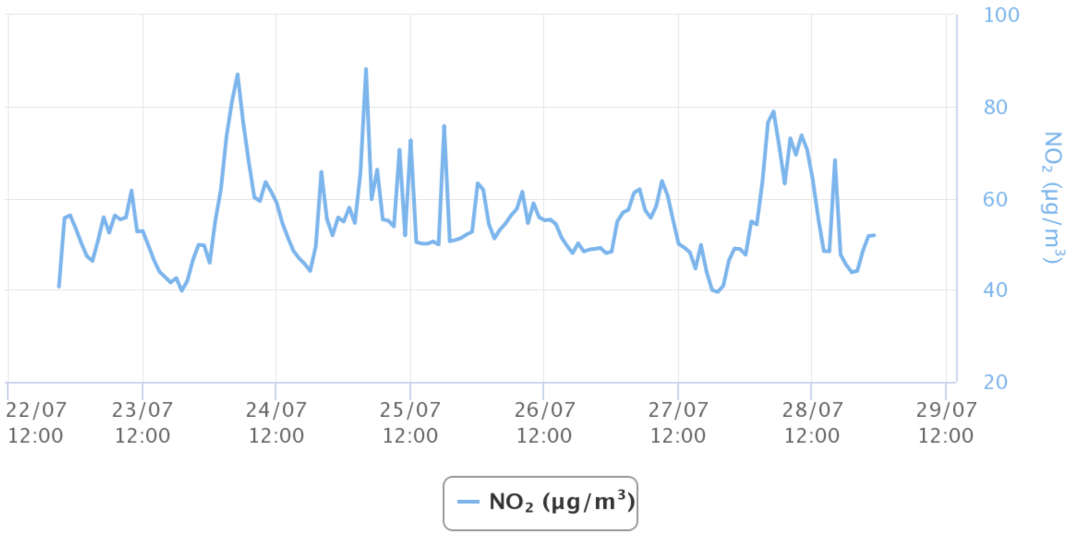

FIGURE 27 NO2 HOURLY AVERAGE _ FOOTRINT AREA

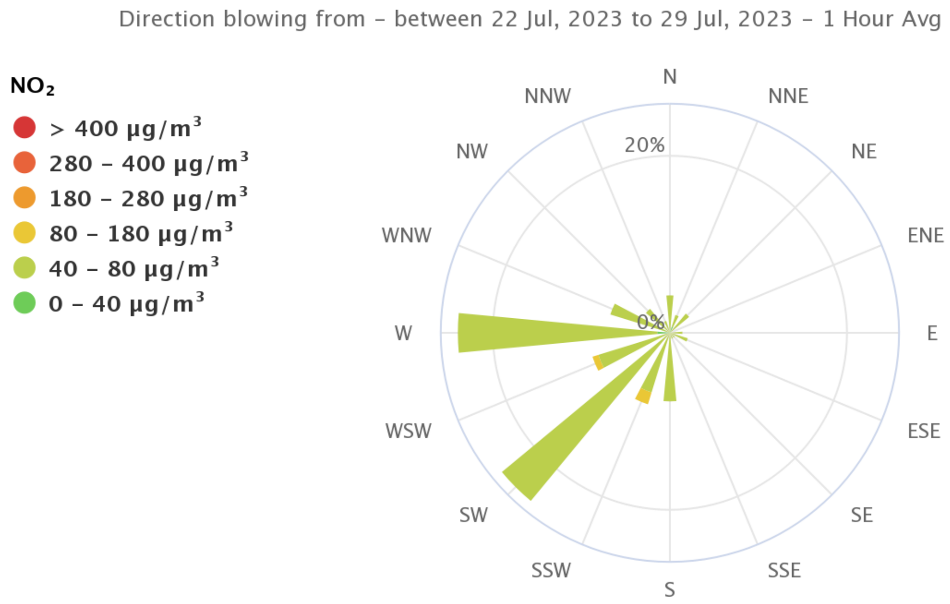

FIGURE 28 NITROGEN DIOXIDE 1 HOURLY POLLUTION ROSE _ FOOTPRINT AREA

7.5. PM2.5

Figure 29 & 30 indicates the levels of $PM_{2.5}$ in the area during the winter month on July 2023. The $PM_{2.5}$ levels range between 0 µg/m^3 and 35 µg/m^3 with some random daily spikes

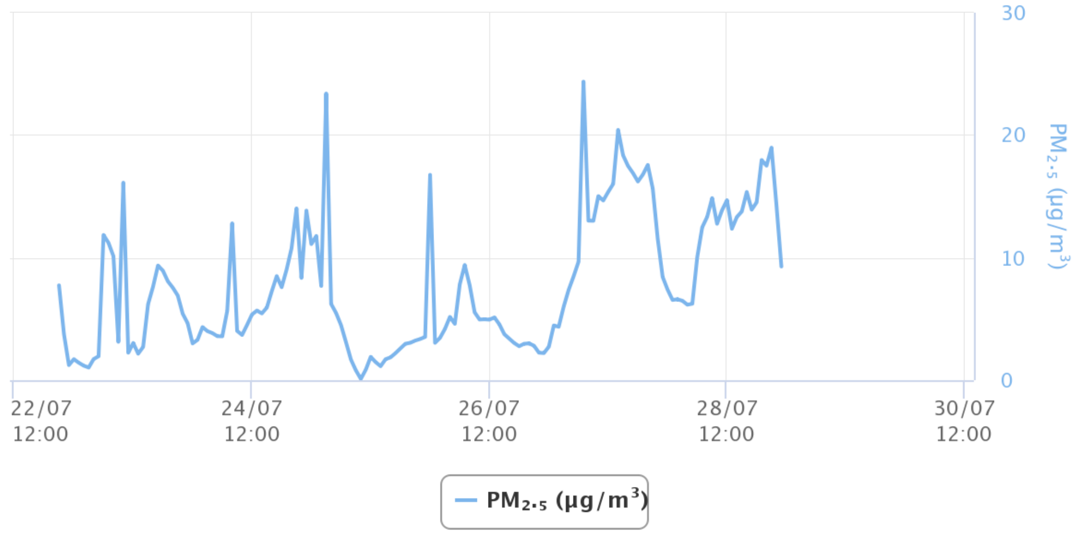

FIGURE 29 PM2.5 24 HOURLY AVERAGE _ FOOTPRINT AREA

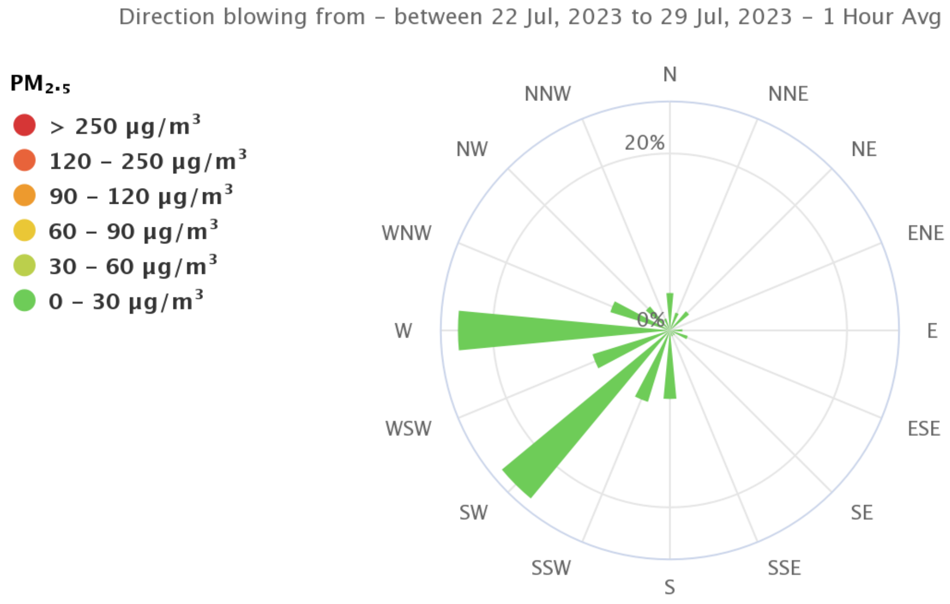

FIGURE 30 PM2.5 POLLUTION ROSE1 HOUR AVE

7.6. OZONE (O_3)

Figure 31 and 32 indicates the levels of O_3 in the area during the winter month on July 2023. The O_3 levels range between 0 µg/m^3 and 38 µg/m^3 with some random weekly spikes.

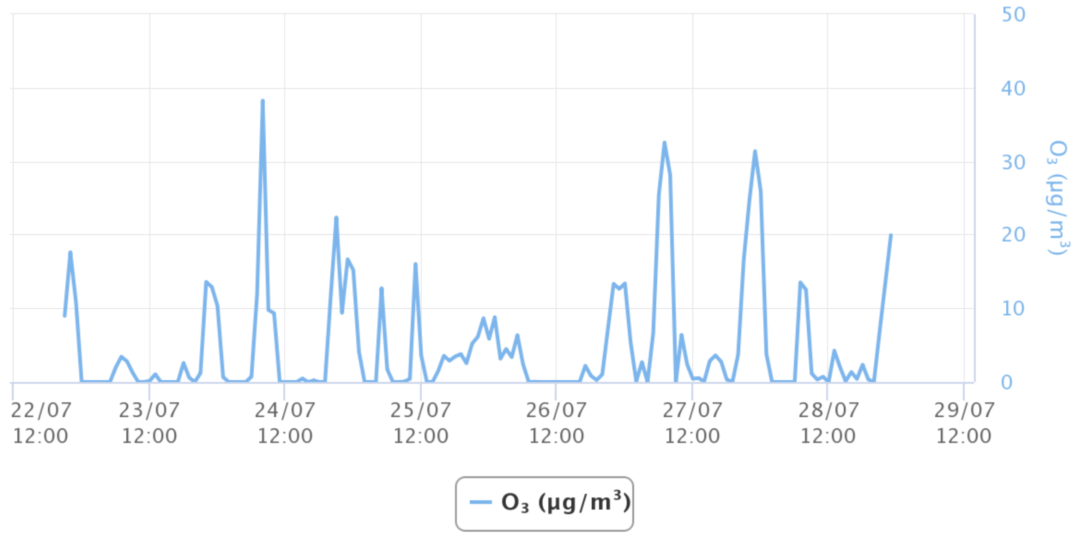

FIGURE 31 OZONE 8 HOURLY GRAPH _ FOOTPRINT AREA

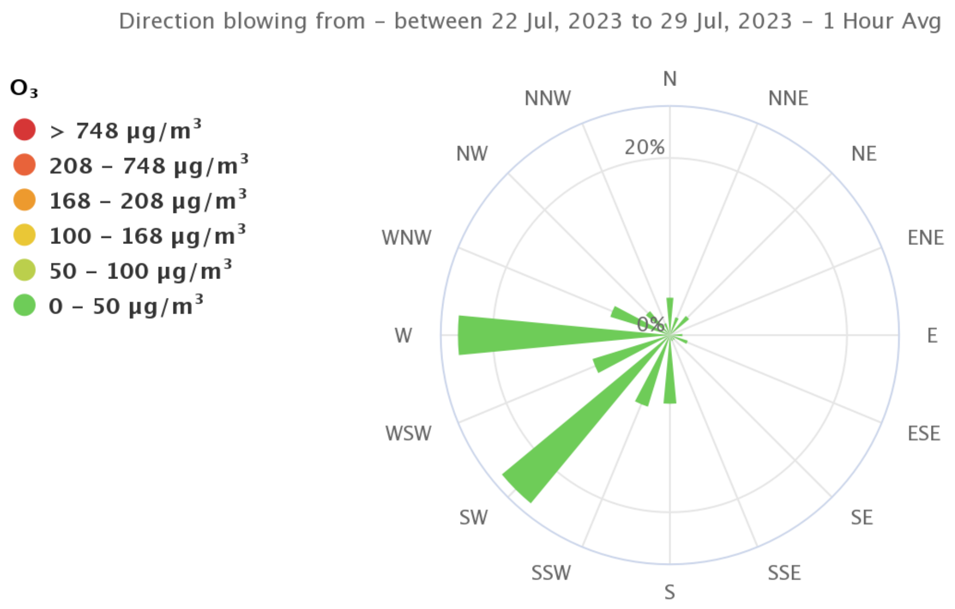

FIGURE 32 OZONE POLLUTION ROSE

7.7. PM_{10}

Figure 33 and 34 indicates the levels of PM_{10} in the area during the winter month on July 2023. The PM_{10} levels range between 5 µg/m³ and 39 µg/m³ with some random weekly spikes

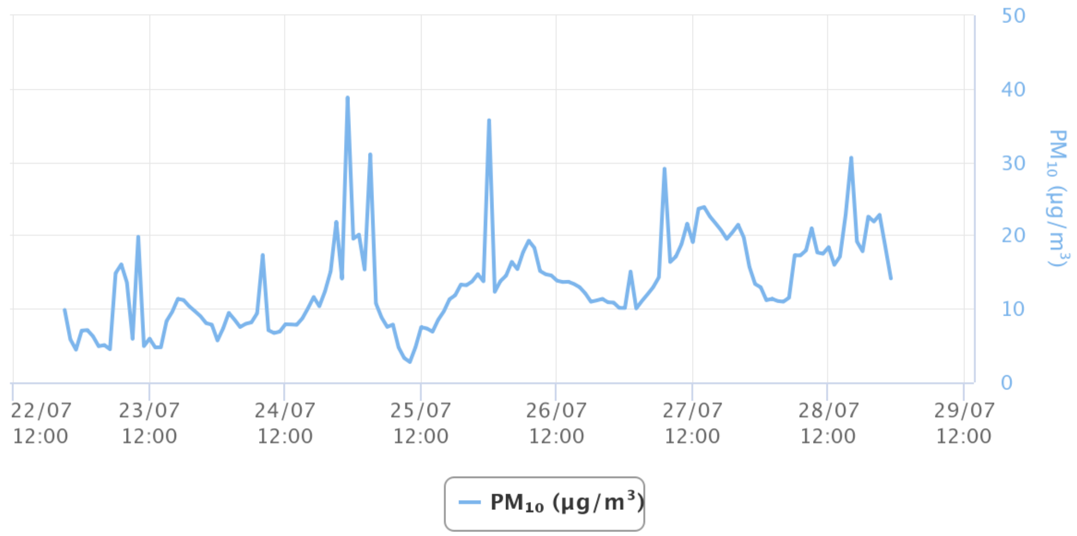

FIGURE 33 PM10 24HR AVERAGE _ FOOTPRINT AREA

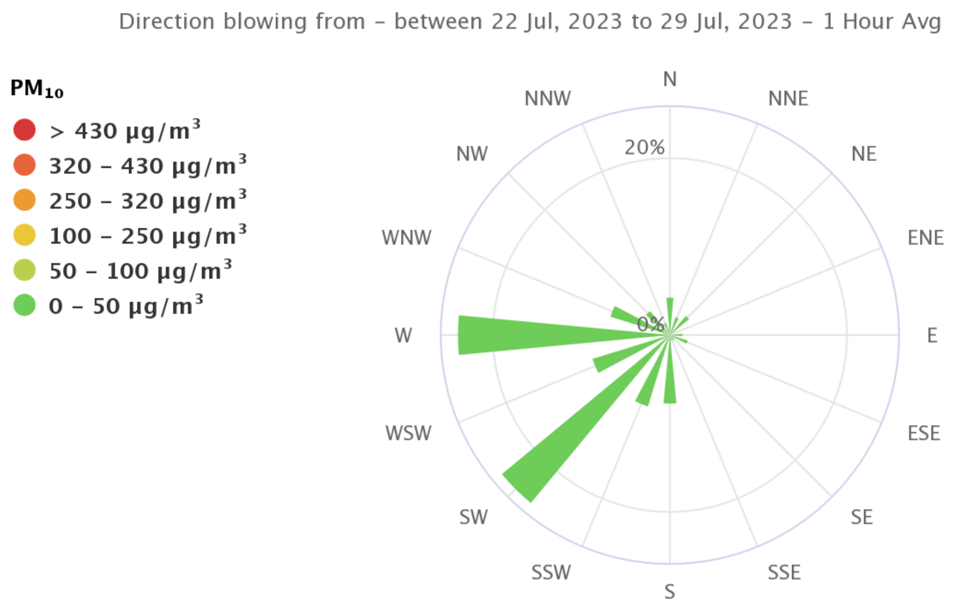

FIGURE 34 PM10 POLLUTION ROSE 1 HOUR AVE

8. MITIGATION MEASURES AND MANAGEMENT PLAN

Mitigation and management measures detailed below will reduce emission of particulate matter from sources into the surrounding environment.

8.1. MATERIAL HANDLING OPERATIONS

Efforts to eliminate dust generation at transfer points in a coal mine may not be entirely feasible, but it can be effectively controlled to fall within compliance with environmental regulations and standards. Enclosures at transfer points are necessary to control emissions and prevent dust from escaping into the atmosphere. To reduce the fall heights at transfer points, spiral chutes can be employed to minimize the impact and dispersion of ore, which helps to control dust emissions during the material transfer process.Load profiling is an important measure to create a consistent surface of ore in each truck, which can help reduce the potential for dust generation during transportation.

The magnitude of ore dust emissions during transport depends on various factors, such as the level of exposure of the open surface to high-speed air and the inherent dustiness of the material. To mitigate dust emissions during transportation, potential modifications to trucks can be considered to minimize wind contact with the ore. Additionally, using water or air blow-down techniques can help reduce parasitic loads on trucks as they exit the load-out bay, further controlling dust emissions. During the crushing process, dust emissions can be managed by enclosing the feed side of the crusher. By using water and having enclosures on the crushers, the release of dust particles into the air can be reduced significantly.

Overall, a combination of engineering controls, such as enclosures and load profiling, along with operational measures like water and air blow-down, can effectively mitigate fugitive dust emissions at various points in the mining process. Proper dust management is crucial to ensure compliance with environmental regulations and to protect the health of workers and nearby communities.

8.2. HAUL ROADS

During the transportation of ore from the shaft to the plant, dust generation is inevitable, leading to increased particulate loading in the atmosphere and reduced visibility due to fugitive dust from haul roads. However, implementing effective dust management measures can significantly reduce fugitive dust from these roads.

Dust suppressants have proven to be effective in controlling dust on haul roads. These suppressants work by forming a layer over the road surface, commonly known as "dust-aside," which helps to mitigate dust emissions.

To ensure the construction of effective haul roads, Midwest Research Institute (1981) recommends several key properties, including resistance to wear, soundness, maximum particle size, particle shape, and gradation.

In summary, dust generation during the transportation of ore can be managed through the use of proven dust suppressants on haul roads. It is essential to construct roads with specific properties to enhance their durability and minimize dust emissions, thus reducing the environmental impact and improving visibility in the vicinity of the mine.

8.3. SPEED CONTROL

Reducing the speed of vehicles on haul roads is indeed an effective method to manage fugitive dust generated during the transportation of ore. However, it is essential to recognize that reducing speed can potentially lower the production rate of the mine.

Studies conducted by Watson et al. in 1996 demonstrated that reducing the speed of vehicles on haul roads from 25 mph (40 km/h) to 15 mph (24 km/h) resulted in a significant reduction of particles less than 10 micrometers in size by approximately 58%. This reduction in speed helps to decrease the turbulence and disturbance of the road surface, leading to lower dust generation. Another approach to manage fugitive dust on haul roads is by reducing the volume of traffic. By minimizing the number of vehicles using the haul roads, the impacts of dust entrainment can be reduced, resulting in lower dust emissions.

While reducing speed and traffic volume can effectively control dust, it is essential to carefully balance these measures with the production requirements of the mine. Striking a balance between managing dust emissions and maintaining productivity is crucial to ensure the sustainable operation of the mine while minimizing environmental impacts. Implementing appropriate dust management measures, such as using dust suppressants and road surface treatments, in combination with speed and traffic controls, can help optimize dust control efforts without compromising the overall productivity of the mining operation.

8.4. LOAD COVERS

Covering loads with tarps is an effective method to prevent the material from becoming airborne during transportation. Research by Chepil (1958) indicates that entrainment, where material particles are lifted into the air by wind, can occur when air flows at speeds exceeding 21 km/h for small materials (0.1 mm in size). Larger materials require even higher wind velocities for entrainment to occur.

By using tarps to cover the loads, the material remains securely contained and protected from wind and other environmental factors that could otherwise cause dust to become airborne. This practice is particularly useful for fine materials that are more susceptible to entrainment. Additionally, wetting the loaded materials is another effective strategy to reduce dust generation. By keeping the material moist, dust particles are less likely to be released into the air during transportation. Watering down the material before loading or using water sprayers on haul trucks can help control dust emissions and improve air quality in the vicinity of the mine.

Combining these dust control measures, such as covering loads with tarps and wetting the material, can significantly reduce fugitive dust during transportation, contributing to better environmental management and mitigating the potential impacts of dust on workers' health and nearby communities.

TABLE 7 RECOMMENDATIONS FOR SITE CLEARING AND PREPARATION

Site clearing and preparation		
Objectives	To comply with the requirements of NEM: AQA; Put measures in place to align the operations with the provisions of South African guidelines on air quality; and To reduce discomfort or nuisance effects on receptors	**Responsibility**
Impacts:	• Fugitive dust and PM emissions associated with: • Demolition and debris removal (including transportation, loading and unloading); • Earthworks; • Vehicular traffic on unpaved roads; and	

	• Material stockpiles.	
Mitigation measure(s)	Training the workforce in awareness of air emissions can be carried out at all levels (workers, foremen, managers) and can be included in site induction courses. Training should focus on promoting understanding as to why mitigation measures are in place; Reduction in unnecessary traffic volumes by developing plans to optimise vehicle usage and movement; Wet suppression on construction access roads with water and a suitable dust palliative to achieve the 95% control efficiency (water alone will only achieve a 75 % control efficiency); Rigorous speed control and the institution of traffic calming measures to reduce vehicle entrainment of dust. A recommended maximum speed of 20 km/h to be set on all unpaved roads and 35 km/h on paved roads; and Use temporary windbreaks in open exposed areas and stockpiles prone to wind erosion to reduce wind speed through sheltering.	
Performance criteria	• Vehicle use and movement optimisation plan; • Evidence of wet suppression on access roads and stockpiles; • Evidence of speed control (e.g. speed bumps or speed limit signage); and • Use of temporary windbreaks.	
Monitoring/ Measurement	Any complaints as to the management of on-site air quality will be directed to the site management. Complaints and any actions arising from a complaint will be recorded in a complaints register to be maintained by site management	

TABLE 8 RECOMMENDATIONS FOR CONSTRUCTION

Construction Phase

Objectives	To comply with the requirements of NEM: AQA; Put measures in place to align the operations with the provisions of South African guidelines on air quality; and To reduce discomfort or nuisance effects on receptors	**Responsibility**
Impacts:	• Fugitive dust and PM emissions associated with: • Demolition and debris removal (including transportation, loading and unloading); • Earthworks; • Vehicular traffic on unpaved roads; and • Material stockpiles.	
Mitigation measure(s)	Training the workforce in awareness of air emissions can be carried out at all levels (workers, foremen, managers) and can be included in site induction courses. Training should focus on promoting understanding as to why mitigation measures are in place; Reduction in unnecessary traffic volumes by developing plans to optimise vehicle usage and movement; Wet suppression on construction access roads with water and a suitable dust palliative to achieve the 95% control efficiency (water alone will only achieve a 75 % control efficiency); Rigorous speed control and the institution of traffic calming measures to reduce vehicle entrainment of dust. A recommended maximum speed of 20 km/h to be set on all unpaved roads and 35 km/h on paved roads; and Use temporary windbreaks in open exposed areas and stockpiles prone to wind erosion to reduce wind speed through sheltering. Employ good housekeeping both inside and outside the construction site, including: cleaning up rubbish and debris,	

	sweeping, hosing down stockpiles or roadways, repairing tears in hessian or shade cloth used for dust attenuation	
Performance criteria	• Vehicle use and movement optimisation plan; • Evidence of wet suppression on access roads and stockpiles; • Evidence of speed control (e.g. speed bumps or speed limit signage); • Housekeeping schedule; and • Use of temporary windbreaks.	**Construction Manager**
Monitoring/ Measurement	Any complaints as to the management of on-site air quality will be directed to the site management. Complaints and any actions arising from a complaint will be recorded in a complaints register to be maintained by site management	

TABLE 9 RECOMMENDATIONS FOR OPERATIONS

Construction Phase		
Objectives	To comply with the requirements of NEM: AQA; Put measures in place to align the operations with the provisions of South African guidelines on air quality; and To reduce discomfort or nuisance effects on receptors	**Responsibility**
Impacts:	• Fugitive dust and PM emissions associated with: • Demolition and debris removal (including transportation, loading and unloading); • Earthworks; • Vehicular traffic on unpaved roads; and • Material stockpiles.	
Mitigation measure(s)	Training the workforce in awareness of air emissions can be carried out at all levels (workers, foremen, managers) and can be included in site induction courses. Training should focus on promoting understanding as to why mitigation measures are in place;	

	Reduction in unnecessary traffic volumes by developing plans to optimise vehicle usage and movement; Wet suppression on construction access roads with water and a suitable dust palliative to achieve the 95% control efficiency (water alone will only achieve a 75 % control efficiency); Rigorous speed control and the institution of traffic calming measures to reduce vehicle entrainment of dust. A recommended maximum speed of 20 km/h to be set on all unpaved roads and 35 km/h on paved roads; and Use temporary windbreaks in open exposed areas and stockpiles prone to wind erosion to reduce wind speed through sheltering. Employ good housekeeping both inside and outside the construction site, including: cleaning up rubbish and debris, sweeping, hosing down stockpiles or roadways, repairing tears in hessian or shade cloth used for dust attenuation	
Performance criteria	• Vehicle use and movement optimisation plan; • Evidence of wet suppression on access roads and stockpiles; • Evidence of speed control (e.g. speed bumps or speed limit signage); • Housekeeping schedule; and • Use of temporary windbreaks.	**Construction Manager**
Monitoring/ Measurement	Any complaints as to the management of on-site air quality will be directed to the site management. Complaints and any actions arising from a complaint will be recorded in a complaints register to be maintained by site management	

TABLE 10 RECOMMENDATIONS FOR DECOMMISSIONING AND CLOSURE PHASE

Construction Phase		
Objectives	To comply with the requirements of NEM: AQA;	**Responsibility**

	Put measures in place to align the operations with the provisions of South African guidelines on air quality; and To reduce discomfort or nuisance effects on receptors	
Impacts:	• Fugitive dust and PM emissions associated with: • Demolition and debris removal (including transportation, loading and unloading); • Earthworks; • Vehicular traffic on unpaved roads; and • Material stockpiles.	**Construction Manager**
Mitigation measure(s)	Training the workforce in awareness of air emissions can be carried out at all levels (workers, foremen, managers) and can be included in site induction courses. Training should focus on promoting understanding as to why mitigation measures are in place; Reduction in unnecessary traffic volumes by developing plans to optimise vehicle usage and movement; Wet suppression on construction access roads with water and a suitable dust palliative to achieve the 95% control efficiency (water alone will only achieve a 75 % control efficiency); Rigorous speed control and the institution of traffic calming measures to reduce vehicle entrainment of dust. A recommended maximum speed of 20 km/h to be set on all unpaved roads and 35 km/h on paved roads; and Use temporary windbreaks in open exposed areas and stockpiles prone to wind erosion to reduce wind speed through sheltering. Employ good housekeeping both inside and outside the construction site, including: cleaning up rubbish and debris, sweeping, hosing down stockpiles or	

	roadways, repairing tears in hessian or shade cloth used for dust attenuation	
Performance criteria	• Vehicle use and movement optimisation plan; • Evidence of wet suppression on access roads and stockpiles; • Evidence of speed control (e.g. speed bumps or speed limit signage); • Housekeeping schedule; and • Use of temporary windbreaks.	
Monitoring/ Measurement	Any complaints as to the management of on-site air quality will be directed to the site management. Complaints and any actions arising from a complaint will be recorded in a complaints register to be maintained by site management	

9. RECOMENDATIONS AND CONCLUSSIONS

The findings of this AQA indicate that the proposed mining development will have both positive and negative impacts. The findings indicate that the proposed mining development will result in the creation of employment and economic development opportunities. Most importantly the locals will experience a socio-economic benefit.

Negative impacts will also be experienced due to migration of job seekers into the area; decline in the quality of life due to air, noise, land and water pollution and increased traffic during construction.

9.1. AIR QUALITY MONITORING PROGRAMME

It recommended that the management of Tenbosch introduce a dust monitoring programme throughout the project life of the mine. This will ensure that historical dust deposition data is available to feed into management practices aimed at reducing impacts from the construction, operation and closure phases of the project

As the area exposed is directly proportional to the amount of dust generated and transported, it is advised that construction activities be limited during the windy periods of August, September and October. If construction has to be done during this period, it is advised to disturb a small area at a time. As trucks are a major source of dust, reducing speed of trucks in haul roads will reduce dust immensely.

In order to determine the wind speed for each particular day, a wind anemometer installed on site should be utilised. Wind speeds are recorded daily and when it exceeds 5.4 m/s (this is the threshold for transporting particles) extra dust control measures need to be carried out. During dust generating periods, sprinkling until it is moist is ideal for haul roads and traffic routes (Smolen et al., 1988). It must be noted however that excessive sprinkling to manage dust may result in runoff from the site.

9.2. PARTICULATE MONITORING PROGRAMME

Tenbosch should establish a fine particulate monitoring programme which should include at least one particulate instrument to monitor either PM_{10} or $PM_{2.5}$. Ideally, both set of pollutants should be monitored as required by regulatory authorities. In addition to pollutants, the ambient monitoring unit should include measurement of meteorological parameters representative of the mining area. Air dispersion modelling should be done and always use site specific data if available. It is advised to install the unit at least one year prior to the construction phase to allow for the collection of ambient air quality baseline data set

9.3. LOCAL EDUCATION AND AWARENESS

It is recommended that Tenbosch facilitate basic air quality awareness training through relevant organisations (e.g. Department of Labour), tertiary education institutions (FET College), and community structures (Community Trusts, Ward councillors etc). Examples of education and awareness materials could include posters, information sharing sessions and skills development workshops, aimed at youth, women, and unemployed. This should allow individuals to become aware of the impacts of air quality on their health and therefore take the necessary precautionary measures.

9.4. GRIEVANCE MECHANISMS AND COMMUNITY FORUM

One of the key requirements of the IFC Performance Standards on Environmental and Social Sustainability is the implementation of a 'Grievance Mechanism' for the duration of the construction and operational phases of the project. This provides a means for the affected stakeholder to communicate any issues or grievances with Tenbosch. The aim of this forum will be to:

1) Receive and register external communications from the public;
2) Screen and assess the issues raised and determine how to address them;
3) Provide, track, and document responses (if any); and
4) Adjust the management programme to meet/ respond to the issues raised.

It is recommended that a Community Forum be established, in order to meet the above requirement. This forum would need to:

- Include members of key potentially affected communities, including at least the surrounding residences (or representative); the local ward councillors, and representatives of disadvantaged communities in the affected areas;
- Be managed by Tenbosch, but chaired by a member of the community;
- Develop a constitution by which the forum will be run;
- Have meetings once every quarter during the construction, operational and closure phases of the project;
- Be held in an accessible place for the members involved (or transport provided by Tenbosch);
- Ensure that issues raised are considered and mitigation/ management measures put in place, as appropriate;
- All issues raised are recorded on a complaints register; and
- All members of the potentially affected public are made aware of the key contact person and contact details.

9.5. RECOMMENDATIONS

Based on the results presented in the report, the following recommendations are supplied:

- Ensure that air quality levels during the construction and operational phase comply with all relevant statutory standards, and that air quality impacts on surrounding sensitive receptors are minimised.
- Adherence to the suggested mitigation measures outlined in this report is recommended in order to reduce anticipated impacts.
- Start ambient air monitoring programmes i.e. PM10.
- The air quality impacts on the mine boundary are to be minimised to ensure compliance
- Any changes to the mine infrastructure will require the dispersion model to be updated accordingly and the management and mitigation to be updated

9.6. CONCLUSSIONS

The Mine is likely to be directly related to a number of factors including: the impact of the mine on natural resources (and local livelihoods); the degree to which local communities are involved, trained and employed by Tenbosch within the mine operations; and the social upliftment that the mine may provide to local communities (including infrastructure and other amenities).

The following pollutants were assessed;

- Carbon Monoxide (CO)
- Nitrogen Oxide (NO)
- Nitrogen Dioxide (NO_2)
- Sulphur Dioxide (SO_2)
- Ozone (O_3)
- $PM_{2.5}$
- PM_{10}

None of the above mentioned pollutants were above the legislated thresholds. The overall Air Quality impact of the proposed Tenbosch mine may be modelled to determine the impacts that may be encountered based on the proposed activities and the site layout plan.

In conclusion, the baseline air quality study for the Tenbosch underground coal mine provides crucial information on the current air quality conditions before the commencement of mining activities. The study's findings serve as a reference point against which future air quality changes can be assessed and impacts of mining operations can be measured.

Through comprehensive monitoring and analysis, the baseline study has identified existing pollutant levels, including particulate matter, sulfur dioxide, nitrogen oxides, carbon monoxide, and ozone. Understanding the initial air quality conditions allows us to establish a clear understanding of potential risks and challenges associated with the mining activities. The study has highlighted areas of potential concern, such as fugitive dust emissions from transfer points, haul roads, and crushing operations. It also underscores the importance of implementing effective dust management measures, such as dust suppressants, load profiling, and road construction with specific properties, to mitigate dust generation during ore transportation.

The baseline study has also shed light on the critical factors affecting air quality, such as vehicle speed, traffic volume, and material moisture content, providing valuable insights for developing targeted mitigation strategies.

As mining operations proceed, continuous monitoring and comparison with the baseline data will be essential to assess any changes in air quality and ensure compliance with environmental regulations. Proactive and adaptive measures can be implemented based on the study's findings to minimize the impact of mining activities on air quality and protect the health and well-being of workers and nearby communities.

Ultimately, the baseline air quality study serves as a fundamental pillar in responsible environmental management for the underground coal mine. By laying the foundation for ongoing monitoring and effective mitigation, the study supports sustainable mining practices and demonstrates our commitment to safeguarding both the environment and public health throughout the mine's operational lifespan should authorisation be granted.

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