SPECIALIST AIR QUALITY IMPACT ASSESSMENT REPORT FOR WONDERSTONE DRIEKUIL MINE EXPANSION, NORTH WEST PROVINCE

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# ABBREVIATIONS

| | |
|---|---|
| **ADT** | Articulated Dump Truck |
| **AEL** | Atmospheric Emission Licence |
| **AERMIC** | American Meteorological Society and US EPA Regulatory Model Improvement Committee |
| **AERMOD** | American Meteorological Society/United States Environmental Protection Agency Regulatory Model |
| **AP-42** | Compilation of Air Pollutant Emission Factors |
| **APPA** | Atmospheric Pollution Prevention Act (Act 45 of 1965) |
| **AQA** | National Environment Management: Air Quality Act (Act No. 39 of 2004) |
| **AQIA** | Air Quality Impact Assessment |
| **AQMP** | Air Quality Management Plan |
| **AQMS** | Air Quality Monitoring Station |
| **AQO** | Air Quality Officer |
| **ARM** | Ambient Ratio Method |
| **ASTM** | American Society for Testing and Materials |
| **BDL** | Below detection limit |
| **BPEO** | Best Practicable Environmental Option |
| **BPIP** | Building Profile Input Program |
| **DEA** | Department of Environmental Affairs |
| **DEFF** | Department of Environment, Forestry and Fisheries |
| **DFFE** | Department of Forestry, Fisheries and the Environment |
| **DME** | Department of Minerals and Energy |
| **DMRE** | Department of Mineral Resources and Energy |
| **DPM** | Diesel particulate matter |
| **EA** | Environmental Authorisation |
| **EEA** | European Environment Agency |
| **EIA** | Environmental Impact Assessment |
| **EMEP** | European Monitoring and Evaluation Programme |
| **EMI** | Environmental management inspector |
| **EMPr** | Environmental management programme |

| | |
|---|---|
| **FVC** | Forced Vital Capacity |
| **GG** | Government Gazette |
| **GLC** | Ground Level Concentrations |
| **GN** | Government Notice |
| **IDP** | Integrated Development Plan |
| **ISCST3** | Industrial Source Complex Short-Term, Version 3 |
| **ISO** | International Organization for Standardization |
| **km** | Kilometre |
| **$km^2$** | Kilometre squared |
| **kt** | Kilotonne |
| **LHD** | Load haul dump |
| **m** | Metre |
| **$m^2$** | Metre squared |
| **mamsl** | Meters above mean sea level |
| **MEC** | Member of Executive Council |
| **MES** | Minimum Emission Standard |
| **MetUM** | United Kingdom Meteorological Office Unified Model |
| **MM5** | Mesoscale model - Fifth generation |
| **MWP** | Mining Work Programme |
| **NAAQS** | National Ambient Air Quality Standards |
| **NDCR** | National Dust Control Regulations |
| **NEMA** | National Environment Management Act, 1998 (Act 107 of 1998) |
| **NFAQM** | National Framework for Air Quality Management |
| **NMMDM** | Ngaka Modiri Molema District Municipality |
| **NW READ** | North West Rural, Environment and Agricultural Development Department |
| **NOMR** | New Order Mining Right |
| **NPI** | National Pollutant Inventory |
| **PBL** | Planetary Boundary Layer |
| **PM** | Particulate Matter |
| **$PM_{2.5}$** | Particulate Matter less than 2.5 microns in diameter |
| **$PM_{10}$** | Particulate Matter less than 10 microns in diameter |

| | |
|---|---|
| **ppb** | Parts per billion |
| **ppm** | Parts per million |
| **PRIME** | Plume Rise Model Enhancements |
| **PSD** | Particle size distribution |
| **RDT** | Rigid Dump Truck |
| **SAAQIS** | South African Air Quality Information System |
| **SADC** | Southern African Development Community |
| **SANAS** | South African National Accreditation System |
| **SANS** | South African National Standards |
| **SR** | Sensitive receptor |
| **SRTM** | Shuttle Radar Topography Mission |
| **TAPM** | The Air Pollution Model |
| **TLM** | Tswaing Local Municipality |
| **TSP** | Total Suspended Particulates |
| **US EPA** | United States Environmental Protection Agency |
| **WHO** | World Health Organisation |
| **WRD** | Waste Rock Dump |
| **WRF** | Weather Research and Forecast modeling system |
| **WST** | Wonderstone Ltd |

# EXECUTIVE SUMMARY

## Outline of the Project

The scope of work for the overall environmental Wonderstone Ltd Project authorisation process encompasses several specialist studies of which Air Quality Impact Assessment (AQIA) forms an integral component. The AQIA was conducted to assess the potential impacts and recommend mitigation measures to reduce emissions to the ambient environment.

## Introduction

VJ Air Modelling Services (Pty) Ltd (hereafter VJ Air) was appointed by EnviroGistics (Pty) Ltd (hereafter EnviroGistics) to undertake an air quality impact assessment for the existing open pit mining project at Wonderstone Ltd (hereby referred as: Wonderstone) and its associated infrastructure, including open pit mining, access roads and processing plant management infrastructures.

The aim of the investigation is to quantify the possible impacts resulting from the proposed project activities on the surrounding environment and human health. To achieve this, a good understanding of the local dispersion potential of the site is necessary and subsequently an understanding of existing sources of air pollution in the region and the resulting air quality.

## Study Approach and Methodology

The investigation followed the methodology required for a specialist report as prescribed in the Environmental Impact Assessment (EIA) Regulations (Government Notice R.326 in Government Gazette 40772 of 07 April 2017).

## Baseline Assessment

A baseline assessment was undertaken which included a geographic overview and a review of available meteorological and monitoring data. In order to characterise the meteorological conditions of the site, local meteorological data was sourced from the Agricultural Research Council meteorological station outside Ottosdal, located approximately 7 km northwest of Wonderstone. Data was acquired for the period January 2017 - December 2019. It was found that winds predominantly originated from the northerly and easterly directions during all seasons of the year, with fastest winds occurring in summer and spring from the north and east.

To understand the air quality status quo of the area, dust fallout data was obtained from Wonderstone. This monitoring was undertaken from 2013 – 2015, with no further monitoring conducted post 2015. Due to the lack of available monitoring data for the area, this dust fallout data has been included, although it is noted this must be viewed with caution given the age of the data, while fallout levels measured are extremely low, especially for a mining operation in a relatively dry environment. With this in mind, fallout levels are noted to be extremely low on the Wonderstone boundary, well below the residential standard of 600 mg/m$^2$/day.

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# 1. INTRODUCTION

Assore Limited that owns Wonderstone Ltd has appointed EnviroGistics (Pty) Ltd (hereafter EnviroGistics) as the Independent Environmental Assessment Practitioner to undertake the environmental authorisation and associated stakeholder engagement process required for the Section 102 to amend rights, permits, programmes or plans in terms of section 102 of the mineral and petroleum resources development act (MPRDA) mineral right application for existing open pit mine, hereby referred as Wonderstone Ltd pyrophyllite mine and its associated infrastructure, including pits, haul roads, waste rock dump and topsoil stockpile.

VJ Air Modelling Services (Pty) Ltd (hereafter VJ Air) was subsequently appointed by EnviroGistics to undertake an air quality impact assessment for the proposed extension of the open pit mine – Wonderstone Ltd and its associated infrastructure.

The mining right application includes all portions of farms Gestoptefontein 349 IO (37 portions) and Driekuil 280 IP (ten portions). Farms Gestoptefontein 349 and Driekuil 280 are situated in the Tswaing Local Municipality, within the Ngaka Modiri Molema District Municipality in the central part of the North West Province. Wonderstone Ltd is located some 8 km north of Ottosdal along the Regional Route R505 that connects Ottoshoop, North West Province in the north with Wesselsbron in the Free State Province to the south.

## 1.1 Scope of Work

The purpose of this investigation is to determine baseline air quality conditions, identify sensitive receptors and quantify and assess the potential impact that the proposed development may have on receiving environment of the surrounding area and prepare specialist impact assessment report for the resolution of the Mining Right Application.

The following tasks, typical of an air quality impact assessment, are included in the scope of work:

- A review of surrounding activities in order to identify sources of emission and associated pollutants;
- A study of regulatory requirements and inhalation thresholds for identified key pollutants against which compliance need to be assessed and health risks screened;
- A study of the environment in the vicinity of the proposed development; including:
    - The identification of potential sensitive receptors (SRs);

  - A study of the atmospheric dispersion potential of the area taking into consideration local meteorology, land use and topography; and
  - The analysis of all available ambient air quality information/data to determine pre-development ambient pollutant levels and dust fall rates.
- The compilation of a comprehensive emissions inventory:
  - Pollutants quantified will include particulate matter (total suspended particulates (TSP), $PM_{10}$ and $PM_{2.5}$).
- Atmospheric dispersion modelling to simulate ambient air pollutant concentrations and dust fall rates as a result of the proposed Wonderstone Ltd Project open pit mining activities.
- A screening assessment to determine:
  - Compliance of simulated criteria pollutants concentrations with ambient air quality standards; and
  - Nuisance dust fall.

- The compilation of a comprehensive air quality specialist report detailing the study approach, limitations, assumption, results and recommendations.

## 1.2 Project Description

This chapter provides a description of the proposed activities, including existing associated structures and infrastructure.

The Wonderstone Mine is located 300 km west of Johannesburg, approximately 8 km to the north of Ottosdal in the North West Province (Figure 1). This area is characterised by gently undulating terrain, with no substantial topographic features. The mine is located in a rural area of which agriculture and mining are the main contributors to the Gross Domestic Product (GDP). Farming includes the growing of grains (maize, sunflowers and peanuts), while farmers also raise cattle, sheep, pigs, dairy cows and chickens.

Farms Gestoptefontein 349 IO and Driekuil 280 IP are situated within the Tswaing Local Municipality.

The issued mining right authorises the extraction of pyrophyllite for a period of 30 years over the farm Gestoptefontein 349 IO:

- Portion 44;
- Area measuring 135.916 ha.

Mining takes place by means of open cast mining, comprising of hydraulic hammering and excavator loading with no drilling and blasting required.

In addition, WST also holds an approved New Order Mining Right (NOMR) NW30/5/1/2/2/397MR (signed 20 March 2019) over various portions of the farms Gestoptefontein and Driekuil 280 IP:

- Portion 5, 7, 9, 10, 11, 24 (portion of portion 5), remainder of portion 15 (a portion of portion 1), portion 20 and portion 40 (a portion of portion 41 now known as portion 44) of the farm Gestoptefontein 349 IO;
- Portions 2, 4, remainder of portion 1, portion 7 (a portion of portion A) and the remainder of farm Driekuil 280 IP.
- Area measuring: 4595.4239 ha

The mining rights combined cover an area of approximately140 ha, of which just under 30 ha has been disturbed by mining activities to date. A large portion of the northern section of the WST mining area on Gestoptefontein has been rehabilitated. Current Wonderstone Mine layout is presented in Figure 3.

The mine is operated under both a new order Mining Right and Converted Mining Right and has various Environmental Authorisations in place to allow for the legal mining and operation of the site.

WST would like to combine its existing mining rights into one, consolidated right, in an attempt to ease the administrative duties and compliance requirements associated with multiple mining authorisations per site.

Wonderstone appointed EnviroGistics (Pty) Ltd to undertake the NEMA, Regulation 34 Environmental Audit during 2019. The audit was completed and submitted to the DMRE on 05 December 2019. Based on the outcomes of the Regulation 34 Audit, the mine has appointed external consultants to conduct the update of the Wonderstone EMPr to address the shortcomings of the current EMPr. In addition to this, various specialist studies have been commissioned to consider the current site conditions and to provide site specific considerations in terms of Best Practical Environmental Management Options to be implemented on site, as the management measures provided in the EMPr are very broad, which results in uncertainty in the implementation of specific requirements.

The intention of the update of the EMPr, is for the mine to operate under one effective Environmental Management Tool. During the past Environmental Audits, it has been determined that the management measures currently stipulated is not clear and site specific and for this reason should be updated to reflect the current site conditions and provide site specific management measures.

This will aid the operation in understanding the holistic management requirements for all approved activities on site. The update will further enhance environmental planning on site in terms of any potential future changes required, by making management objectives and requirements clear for defined activities.

A mining operation is continuously progressing towards best operational practices, improving on production and economics of scale. With this there is an ongoing update and progressing of Environmental Legislation and the understanding of site conditions based on continuous surface water, groundwater, vegetation monitoring etc. being undertaken. In the process the environmental management plan may become outdated. By not allowing the update of the EMPr, the mine will continue with its current environmental management system, with limited understanding of the impact of the operations on the environment and an opportunity to improve on environmental management measures will be lost.

In addition to this, the mine will also apply for new mining operations to the north of the current Block 1N (existing opencast pit) as presented in earlier sections. This application therefore will consider both the R34 amendments, as well as the application for new uses.

### 1.2.1 New project activities

The mine will continue mining from the existing Wonderstone Opencast Pit, and will include the additional five (5) mining blocks (Blocks 2N to 6N, see Figure 2). The mineral to be mined is Pyrophyllite, an aluminium silicate of the phyllosilicate family, with the chemical formula $Al_2Si_4O_{10}(OH)_2$.

The Pyrophyllite will be mined using an excavator equipped with a hydraulic hammer that will break the stone loose, an excavator with a shovel will load the usable stone on dump trucks that will transport the stone to the processing plant. Unusable stone will be transported to the low-grade stockpile (current Waste Rock Dump (WRD)) for possible use in future or to a new WRD which will be located in close proximity to the proposed mining blocks. Mining will be done using the bench method with benches not higher than 5 meters. In addition to this, the mine will undertake ongoing rehabilitation.

1. The intent of the mine is to commence with mining operations on Block 2N (2027/2028) and Block 3N (2029).

2. All the low grade from Block 2N will be placed on the proposed WRD as no void will be available for backfilling;

3. Once Block 2N is completed, backfilling will commence into this block from the year 2034 from Block 3N, Block 4N (from 2035) and Block 5N (from 2036).

4. Once Block 3N is completed, backfilling from Block 4N will take place into Block 2N until filled, and then Block 3N.

5. The Waste Rock Dump will therefore only receive low grade from the total Block 2N, with the first three (3) years of Block 3N and first two (2) years of Block 4N low grade also being place on this facility.

6. The remainder of Block 3N will be backfilled into Block 2N (however leaving a void for the first year of Block 5N's low grade) and Block 4N up until Block 2N is backfilled, whereafter this material will be backfilled into Block 3N.

Once Block 5N and 6N begins, no disposal will be required on the WRD, and all material will be placed in open voids. This will however result in voids remaining in potentially Block 4N, Block 5N and Block 6N.

It should however be noted, that two areas are demarcated for the temporary storage of overburden which will be used for backfilling of the opencast pits in the future, sorting of low grade and high grade material and the placement of topsoil.

Existing haul roads will be used but will have to be extended to the new mining area.

The project will involve:

- Mining:
  - Mining of existing area (Block 1N – about 15ha)
  - five (5 mining blocks (2.5ha, 2.1ha, 2.1ha, 2ha, 2.9ha), which will be mined at different time intervals via opencast mining methods)
  - Area: Approx. 12ha (considering 14ha, for inclusion of the area between Block 5 and Block 5)
- Stockpiles:

    - Two areas (3.4 and 3.2ha) have been identified for the temporary stockpiling of overburden – the mine will commit to ongoing rollover mining – but due to the time sequence, material will be stockpiled in these areas. For your studies, please look at these blocks and indicate whether there are any areas within these blocks which must be avoided. Important to note that the existing Waste Rock Dump will remain operational at 13.4ha.
    - Provision in the two new areas must be for topsoil and overburden/waste rock (volumes is still to be finalised).
    - A new WRD of about 4ha is currently planned, which will likely comprise of a Pollution Control Dam (PCD)
- Other:
    - Two roads (eastern and western roads)
        - Eastern Road at 1.9km at 6m width
        - Western Road at 1.8km at 6m width
    - Roads will be gravel/sand – not tarred.

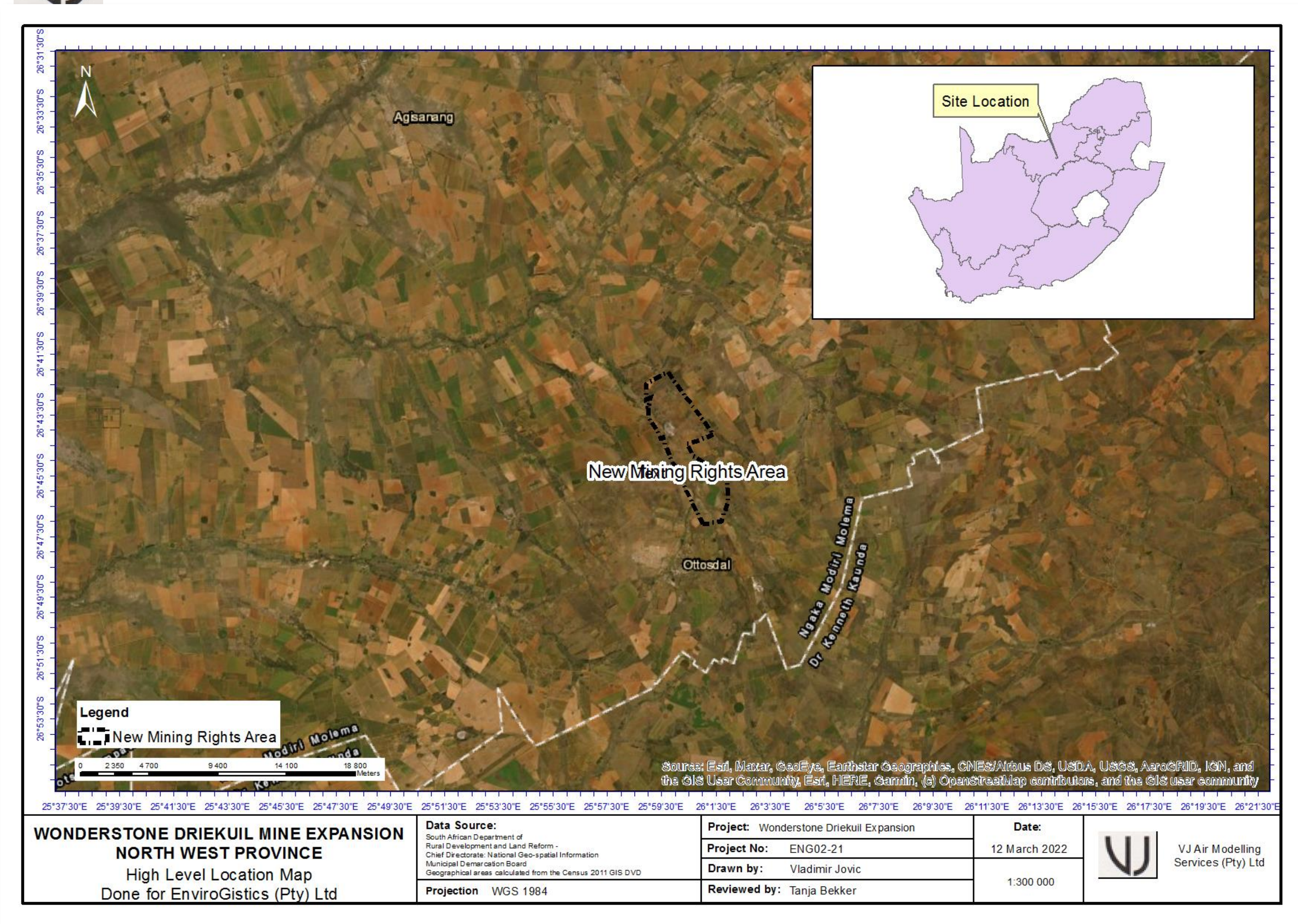


**Figure 1: High-level location map for the Wonderstone Mine.**

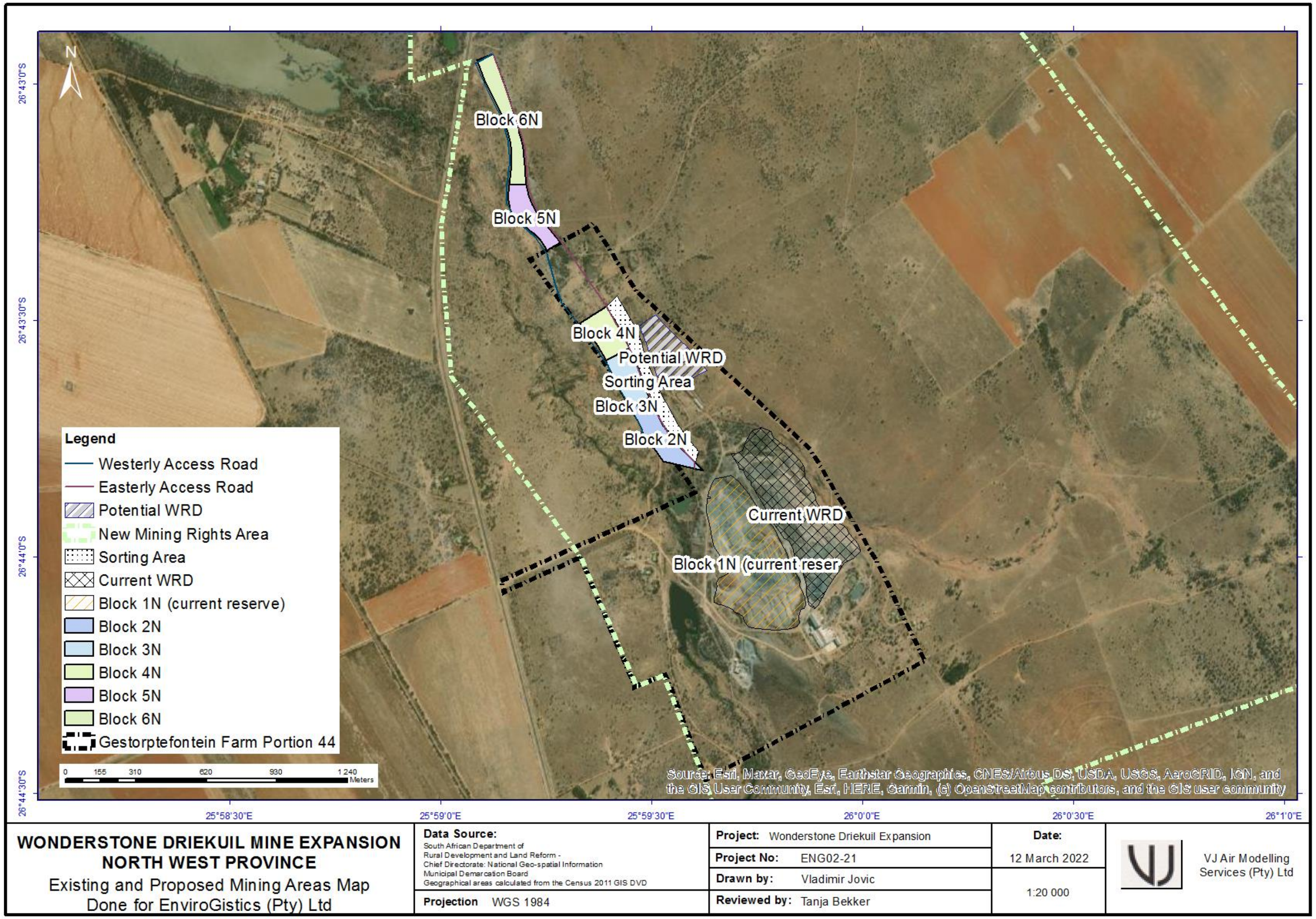


**Figure 2: Existing and proposed mining areas at the Wonderstone Mine.**

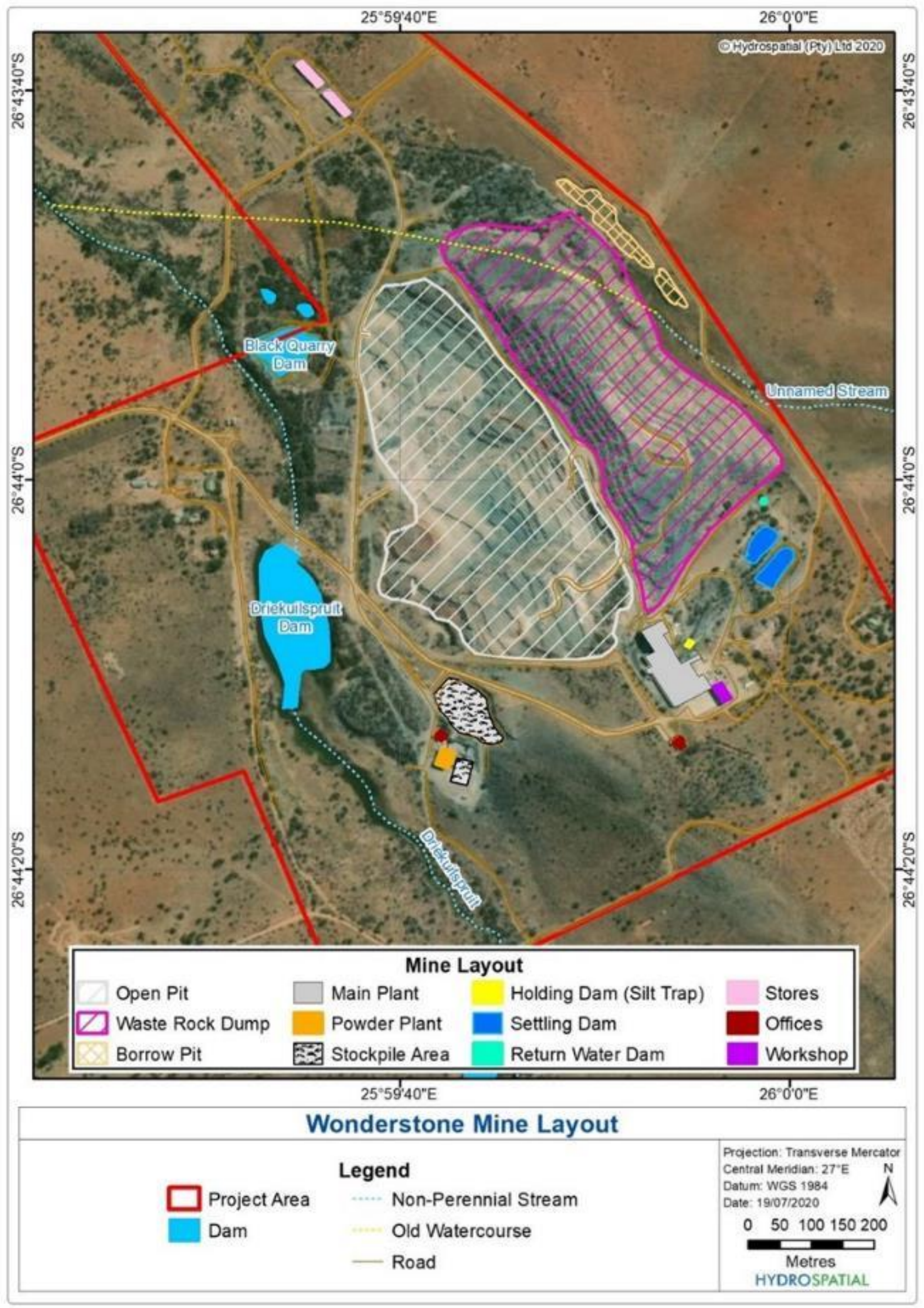


**Figure 3: Current Wonderstone Mine Layout (EnviroGistics, 2022).**

Figure 4 provides a process flow diagram of existing operations at the Wonderstone Ltd mine.

## 1.3 Description of Project Activities in terms of Air Quality

The Wonderstone Mine commenced mining operations in 1937 for a uniquely pure form of pyrophyllite. This mineral has a slightly slippery feel, and is, basically, aluminium silicate in the form of metamorphosed clay originally derived from volcanic ash. This mineral deposit is known to be highly un-reactive and remains chemically inert even when exposed to high temperature and pressure (EnviroGistics, 2021).

On the surface, where weathering has taken place, the pyrophyllite appearance is light grey; however, as one goes deeper into the deposit, the grey colour becomes darker. This is due to higher carbon content, but this does not seem to alter the commercially exploitable qualities of the material. The ash was laid down in layers, which led to its earliest use (EnviroGistics, 2020).

Wonderstone mines Pyrophyllite for trading purposes in an open cast operation using hydraulic hammering and excavator loading without drilling and blasting processes. Excavation is undertaken along a 100 m face with 8 m high benches. A Komatsu shovel loads the slabs of rock into either a Bell or a Caterpillar dump truck, which is then hauled to the plant for processing.

Key products from Wonderstone include:

- Various components (e.g. gaskets) supplied to the synthetic diamond manufacturers, manufactured either through powder pressing or direct machining of pyrophyllite blocks;
- Technical ceramics, such as coil forms and bars, electrical application parts, gas burner tips, welding cups, atomising nozzles and filler for train brakes;
- Industrial minerals being supplied in various particle size distributions, e.g. coarse powder and fine powder.

The processing of pyrophyllite is undertaken at two plants, namely the Powder Plant and Main Plant. For the period July 2019 – June 2020, approximately 79% (67,410 tons) of material excavated from the quarry was transferred directly to the low grade waste rock dump, with 15% (12,690 tons) being delivered to the Powder Plant and 6% (5,208 tons) to the Main Plant for processing. Figure 4 illustrates the process flow at Wonderstone Mine, as discussed further in Section 1.3.1 and Section 1.3.2.

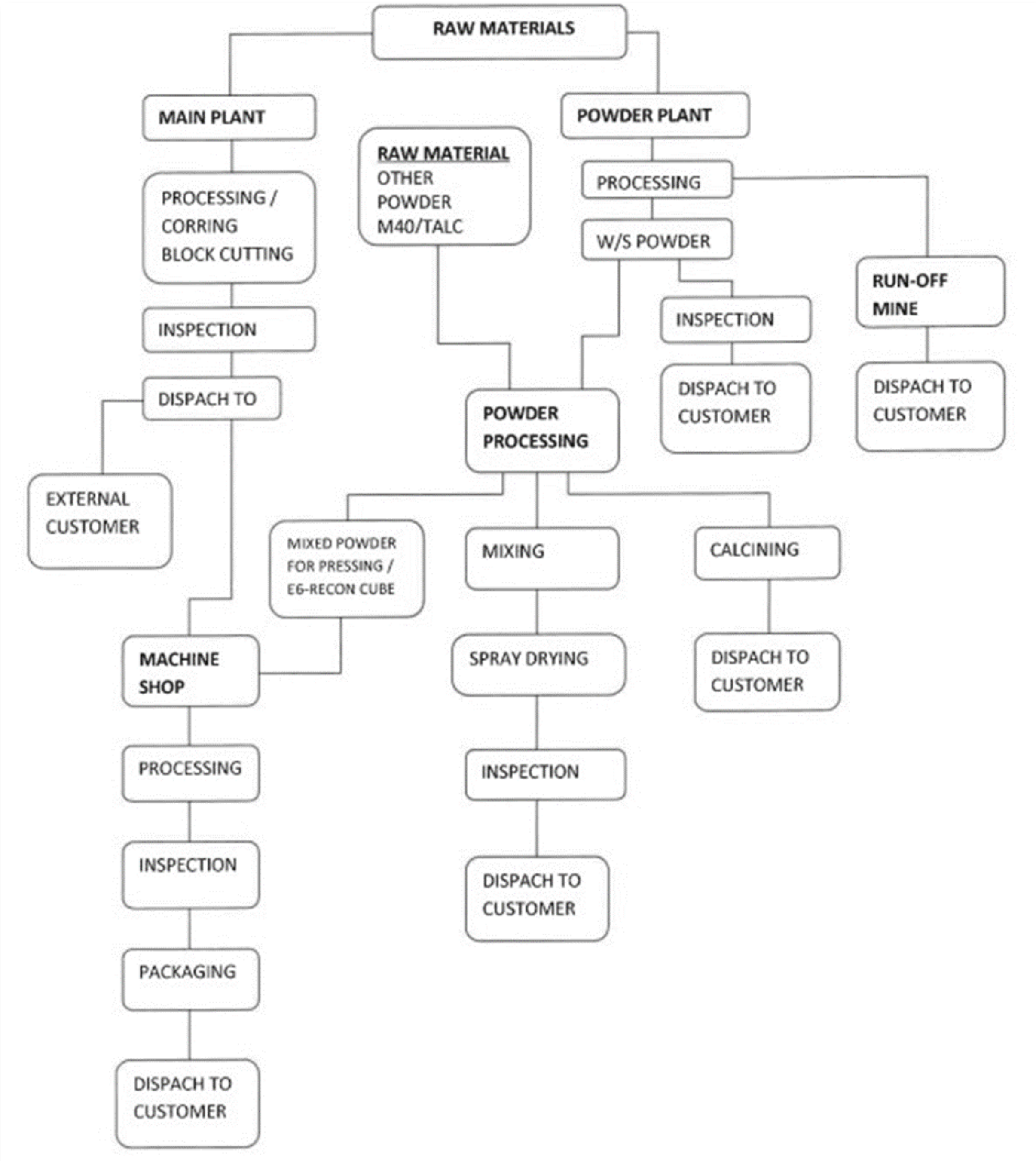


**Figure 4: Process flow at Wonderstone (Source: Wonderstone Mine, 2020).**

### 1.3.1 Powder Plant

Most material from the quarry is delivered to the Powder Plant for processing. Processing at the Powder Plant is undertaken via two Processing Lines. Processing Line 1 comprises a tip, conveyors, feeders, a primary crusher and grizzly screen, with 12,690 tons processed by this line in the prior 12-months. After crushing and screening, material is stockpiled on the Run of Mine (RoM) stockpile for dispatching to clients. Further processing of approximately 25 tons of this material is undertaken in Processing Line 2. This line comprises feed bins, conveyors, a primary and secondary crusher, a beaver mill and screens (2 x sweco and 2 x kroosh screens).

After processing, this material is inspected and transferred to the Main Plant for further processing.

### 1.3.2 Main Plant

Blocks of pyrophyllite are delivered to the Main Plant from the quarry. This material undergoes primary processing comprising saws cutting material into required sizes, followed by secondary processing comprising coring and block cutting. A portion of this material is then dispatched to client, with the remainder being transferred to the Machine Shop for further processing via a CNC lathe and machining centre.

The material received from the Powder Plant is mixed with additional raw materials (talc and M40 powder) and undergoes powder processing, comprising a ball mill, gas calciner and spray drying. After inspection, this material is dispatched to client.

### 1.3.3 Anticipated impact from the air quality perspective

The main focus of the air quality impact assessment is the impact of the open pit mining activities and associated infrastructure (various stockpiles, existing WRD and a new planned WRD, crushing, main and powder plant and haul roads) on the surrounding environment.

Air quality impacts will be associated with the construction phase of the proposed operations; however, these will be of short duration and will not have an impact itself on the proposed operation.

Construction is commonly of a temporary nature with a definite beginning and end. It usually consists of a series of different operations, Each of the operations in Table 1 has its own duration and potential for dust generation. Particulate emission will vary substantially from day to day depending on the phase of construction, the level of activity and the prevailing meteorological conditions (US EPA, 1996). This is in contrast to most other fugitive dust sources, where emissions are either relatively steady or follow a discernible annual cycle. A large portion of the emissions results from equipment traffic over temporary roads at the construction site (US EPA, 1995). The impacts are likely to be localised and will depend on the dispersion potential of the site.

During decommissioning, bulk earthworks and demolishing activities are expected Table 3. Very little information regarding specific activities during the decommissioning phase is available for consideration. The potential for impacts during this phase will depend on the extent of rehabilitation efforts during closure. Simulations of the decommissioning phase will not be included in the current study due to its temporary impacting nature.

This report therefore only focusses on the air quality impact from the existing and proposed operational activities on the surrounding environment (Table 2).

It is important to note that, in the discussion, regulation and estimation of PM emissions and impacts, a distinction is made between different particle size fractions, namely: Total Suspended Particles (TSP), $PM_{10}$ and $PM_{2.5}$. Total Suspended Particles is the fraction sampled with high-volume samplers, approximately particle diameters <50-100 µm. Under windy conditions, the mass tends to be dominated by large wind-blown soil particles of relatively low toxicity. $PM_{10}$ is defined as particulate matter with an aerodynamic diameter of less than 10 µm and is also referred to as thoracic particulates. Respirable particulate matter, $PM_{2.5}$, is defined as particulate matter with an aerodynamic diameter of less than 2.5 µm. Whereas $PM_{10}$ and $PM_{2.5}$ fractions are considered to determine the potential for human health risks, TSP is included to assess nuisance effects.

**Table 1: Typical sources of air emissions associated with construction activities.**

| Impact | Source | Activity |
|---|---|---|
| **Gaseous pollutants (Combustion products including $NO_x$ (oxides of nitrogen), $CO_2$ (carbon dioxide), CO (carbon monoxide), and $SO_2$ (sulfur dioxide)** | Vehicle tailpipe emissions (Dump Trucks, Excavators, Front-end Loaders, Bulldozers, Graders, Backhoe Loaders, etc.) | Transport of material and general construction activities |
| **$PM_{10}$ $PM_{2.5}$ and Dustfall** | Transport infrastructure | Levelling and grading of proposed haul roads areas |

**Table 2: Typical sources of air emissions associated with the operation of Wonderstone Ltd open pit mine.**

| Impact | Source | Activity |
|---|---|---|
| **Gases (Combustion products including $NO_x$ (oxides of nitrogen), $CO_2$ (carbon dioxide), CO (carbon monoxide), and $SO_2$ (sulfur dioxide)** | Transport Vehicles (Dump Trucks) tailpipe emissions | Transport and general activities |
| | Equipment tailpipe emissions (Front-end Loaders, Bulldozers, Backhoe Loaders) | Moving and hauling of waste to waste rock dumps, loading of RoM from RoM pad to haul trucks |

| Impact | Source | Activity |
|---|---|---|
| $PM_{10}$ $PM_{2.5}$ and Dustfall | Transport infrastructure | The vehicle-generated re-entrained road dust |
| | | Fugitive dust from truck loads |
| | Wind Erosion | Fugitive dust from exposed areas |
| | | Fugitive dust from various stockpiles |

Table 3: Activities and aspects identified for the decommissioning phase.

| Impact | Source | Activity |
|---|---|---|
| $PM_{10}$ $PM_{2.5}$ and Dustfall | Stockpiles | Dust generated during rehabilitation activities |
| | Associated infrastructure | Demolition of the associated infrastructure |
| Gases | Vehicle tailpipe emissions | Tailpipe emissions from vehicles and equipment utilised during the closure phase |

## 1.4 Identification of Potential Air Pollution Impacts

Air emissions during existing and future activities will result from a variety of air emission sources, which include material transfer, crushing and screening, wheel entrainment, vehicle exhaust tailpipe and processing activities. Airborne particulates are the most significant of these emissions and may contain airborne particulate sizes up to about 100 micron in diameter. Particles of sizes larger than about 75 micron tend to deposit out of the plume relatively nearby their source of emission. Particles less than about 20 micron, on the other hand, can be carried for considerable distances before depositing out. Dust emissions are produced from the mechanical movement of large volumes of material, as well as by the movement of mobile equipment and trucks along the unsealed (gravel) roadways adjacent to these areas. Dust particles, especially the very fine particles, will potentially be harmful to human health, may create amenity issues and might result in the soiling of buildings, structures and other objects at nearby residences. Particle fallout in significant quantities can also negatively impact vegetation due to the reduction in photosynthesis. Tailpipe emissions from diesel-powered equipment and trucks can also have an impact in terms of gaseous pollutants (diesel particulate matter, $SO_2$, $NO_2$ and CO).

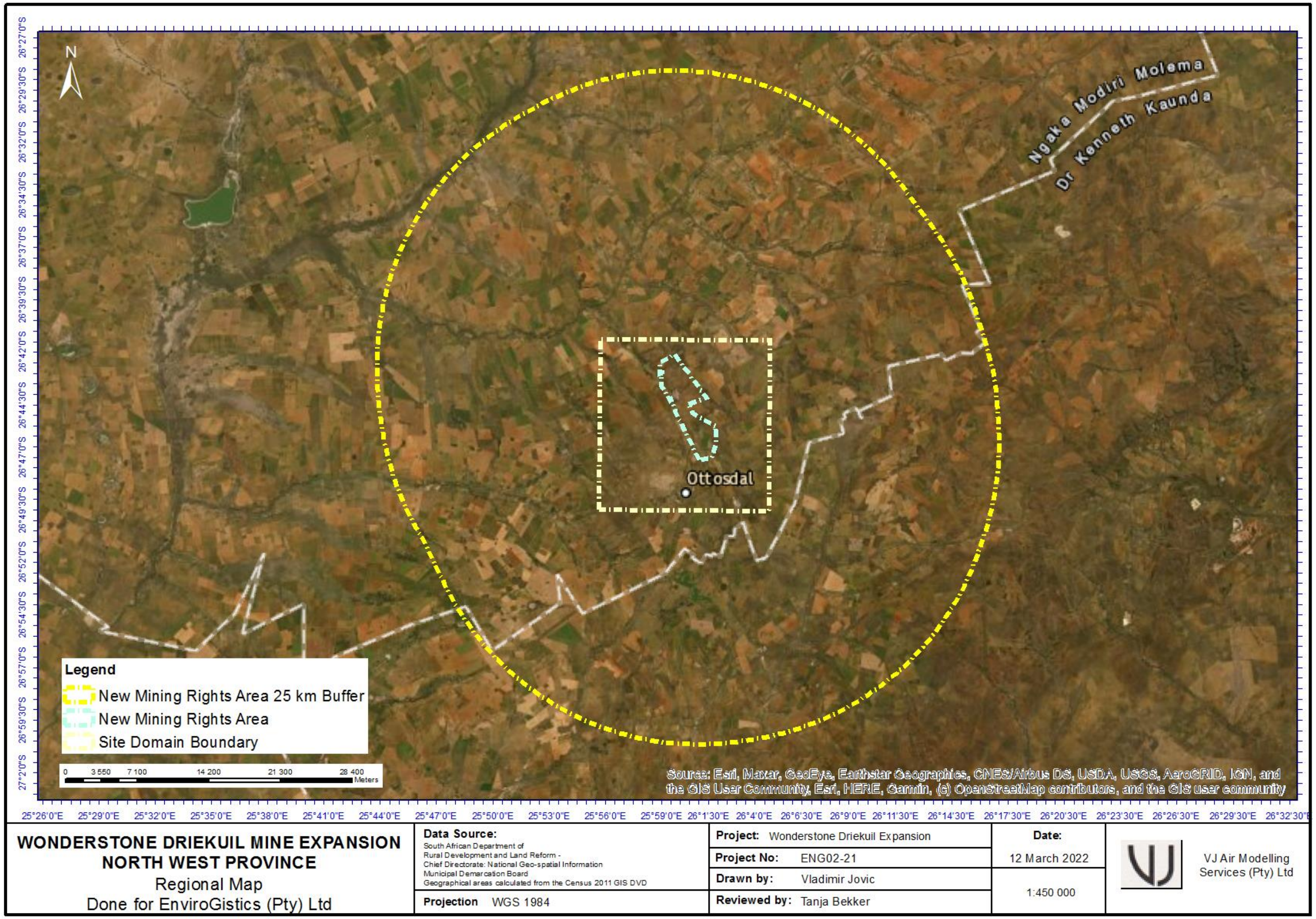


**Figure 5:** **Regional Settings Map showing proposed Wonderstone Ltd Project in relation to the surrounding area (25 km radius).**

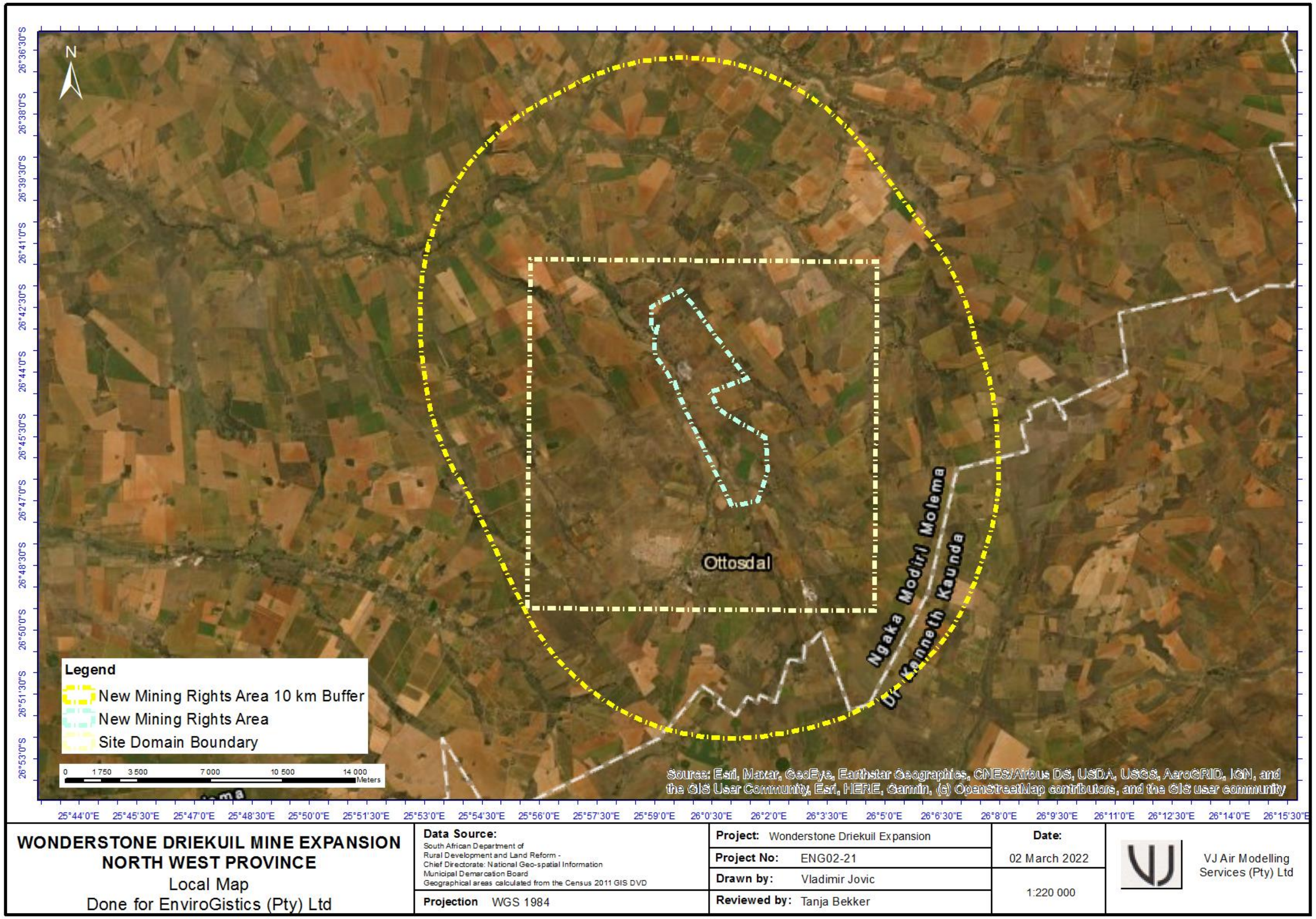


**Figure 6: Local Settings Map showing proposed Wonderstone Ltd Project in relation to the surrounding areas on the satellite map (10 km radius)..**

## 1.3 Approach and Methodology

The approach and methodology followed in the completion of tasks included in the scope of work are discussed below:

### 1.3.1 Project Information and Activity Review

All project related information referred to in this study was expected to be provided by EnviroGistics (Pty) Ltd.

### 1.3.2 The Identification of Regulatory Requirements and Screening Criteria

In the evaluation of ambient air quality impacts and dust fall rates reference was made to:

- South African National Ambient Air Quality Standards (NAAQS); and
- National Dust Control Regulations (NDCR) as set out in the National Environmental Management Air Quality Act (Act No. 39 of 2004) (NEM: AQA).

### 1.3.3 Study of the Receiving Environment

An understanding of the atmospheric dispersion potential of the area is essential to an air quality impact assessment.

Site-specific Weather Research and Forecasting (WRF) modelled meteorological data set for full three calendar years (2019 – 2021) was obtained from the Meteosim, S.L, a company specialising in meteorological and environmental services from Spain, to determine local prevailing weather conditions. This dataset consists of surface data, as well as upper air meteorological data that is required to run the dispersion model. WRF model is a next-generation mesoscale numerical weather prediction system designed for both atmospheric research and operational forecasting applications. It features two dynamical cores, a data assimilation system, and a software architecture supporting parallel computation and system extensibility. The model serves a wide range of meteorological applications across scales from tens of meters to thousands of kilometres. This data has been tested extensively and has been found to be extremely accurate.

Modelled meteorological data for the period January 2019 to December 2021 was obtained for a point close to the existing mine site (26°44'5.18"S, 25°59'54.78"E). Data availability was 100%. Generally, a data set of greater than 90% (taken to be the same as that stipulated for pollutant data availability (SANS, 2011)) is required in order for that month/year to be considered representative of the assessed area.

According to the Regulations regarding dispersion modelling (Government Gazette, 2014) mesoscale models offer an alternative to meteorological measurements as input for Gaussian-plume models and advanced dispersion models. Mesoscale models use gridded meteorological data and sophisticated physics algorithms to produce meteorological fields at defined horizontal grid resolutions and in multiple vertical levels over a large domain. A number of meteorological model datasets covering South Africa are available from a number of vendors. The Code of Practice refrains from recommending specific datasets but encourages modellers to use data from the United Kingdom Meteorological Office Unified Model (MetUM), Weather Research and Forecasting (WRF), The Air Pollution Model (TAPM) and the 5$^{th}$-generation Mesoscale Model (MM5).

### 1.3.4 Determining the Impact of the Project on the Receiving Environment

The establishment of a comprehensive emission inventory formed the basis for the assessment of the air quality impacts from the proposed Wonderstone Ltd Project activities on the receiving environment.

The intent of the study will be to look at the baseline conditions (with the exiting plant, opencast pit and WRD and what the impact will be with the addition of the new pits, roads and planned new WRD.

In terms of air quality, atmospheric emissions represent the environmental aspects of concern for the assessment of the proposed project. The sources of these emissions were determined by first identifying the inputs and outputs to the various processes and secondly considering the disturbance to the environment by the proposed Wonderstone Ltd Project operations. Possible aspects associated with the proposed operations of relevance in terms of air quality impacts are listed in Table 2. Particulates represent the main pollutant of concern in the assessment of mining operations. The particulates in the atmosphere may contribute to visibility reduction, pose a threat to human health, or simply be a nuisance due to their soiling potential.

### 1.3.5 Compliance Assessment

Compliance was assessed by comparing simulated ambient criteria pollutant concentrations ($PM_{2.5}$ and $PM_{10}$) and dust fall rates to selected ambient air quality and dust fall criteria.

### 1.3.6 Impact Significance

The significance of impacts was determined in line with the requirements for impact assessment as outlined in the NEMA (Act 109 of 1998), as amended.

## 1.4 Assumptions, Exclusions and Uncertainties

The following important assumptions, exclusions and uncertainties to the specialist study should be noted:

- Meteorological data from a data point for the project site for the period 2019-2021 was extracted from the WRF data set.
- The impact assessment was limited to criteria particulates (including TSP, $PM_{10}$ and $PM_{2.5}$).
- Constructional phase impacts of the proposed development were not quantified. These impacts are expected to be of short duration.
- There will always be some degree of uncertainty in any geophysical model, but it is desirable to structure the model in such a way as to minimize the total error. A model represents the most likely outcome of an ensemble of experimental results. The total uncertainty can be thought of as the sum of three components: the uncertainty due to errors in the model physics; the uncertainty due to data errors; and the uncertainty due to stochastic processes (turbulence) in the atmosphere. Nevertheless, dispersion modelling is generally accepted as a scientific and valuable tool in air quality management.

- The impact assessment focused primarily on particulate emissions, these having been identified as the primary pollutants associated with the existing and proposed activities at the mine.
- No baseline particulate air pollution monitoring data could be sourced for the existing proposed location. The predicted concentrations were therefore limited to incremental impacts only.
- Historical monitoring data exists for dust fallout but given the age of this dataset, the data must be viewed with caution, and may not necessarily represent the

current air quality situation of the area. Further, the dust fallout levels measured during 2013-2015 period were unrealistically low for a mining area and relatively dry environment.

- It was not possible to provide short-term mining activities; therefore average conditions and process throughputs were assumed.
- Mining operations were assumed to be twenty-four hours over 365 days per year.
- Routine emissions for the existing and proposed mining operations were simulated.
- Entrained specks of dust from vehicles were confined to the main haul roads, since the locations of other traffic routes are premature at this stage of the design.

## 1.5 Gaps in Knowledge

The following was identified as gaps in knowledge during the specialist study and should be noted:

- The quantification of sources of emission was restricted to the existing and future operational activities at the mine identified in the study scope. Hence, only incremental impacts due to $PM_{10}$, $PM_{2.5}$ and dust fall are simulated from the existing and proposed operational activities. Other sources in the area (e.g. tailpipe exhaust emissions from vehicles moving along the Regional Road R505, domestic fuel combustion, veld fires and emissions from other mining operations in the region), could also be contributing to the ambient air. Background data for the area did not meet the requirements in terms of availability (%).

- Other sources in the area, could also be contributing to the ambient air. No recent on-site ambient data is available for the existing and proposed development site in terms of particulate matter and dust measurements.

- Atmospheric dispersion modelling will be used during the EIA phase to assess the extent of the impact of the proposed extension of the existing open pit mine and the cumulative impact of the pollutants of concern.

# 2. REGULATORY REQUIREMENTS AND IMPACT ASSESSMENT CRITERIA

Prior to assessing the impact of the Wonderstone Ltd Project activities on human health and the environment, reference needs to be made to the environmental regulations governing the impact of such operations i.e. emission standards, ambient air quality standards and dust control regulations.

Emission standards are generally set for point sources and specify the amount of the pollutant acceptable in an emission stream and are often based on proven efficiencies of air pollution control equipment.

Air quality guidelines and standards are fundamental to effective air quality management, providing the link between the source of atmospheric emissions and the user of that air at the downstream receptor site. The ambient air quality standards and guideline values indicate safe daily exposure levels for the majority of the population, including the very young and the elderly, throughout an individual’s lifetime. Air quality guidelines and standards are normally given for specific averaging or exposure periods. This section summarises legislation for criteria and non-criteria pollutants relevant to the study and dust fall impacts.

## 2.1 2017 National Framework for Air Quality Management in the Republic of South Africa

The requirements for a National Framework on Air Quality Management in South Africa (NFAQM) are stipulated in section 7 of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004), herein after referred to as the AQA. The AQA requires the Minister, by notice in the Gazette, to establish a National Framework for achieving the objectives of the AQA. To this end, the minister published the First National Framework in 2007. As an inaugural framework, the 2007 framework was a less technical document that aimed at unpacking the AQA in some detail to ensure that all South Africans understand the intentions of the AQA. The provisions for the review of the National Framework are given in section 7 (5)(b) of the AQA which states that the framework must be reviewed by the Minister at intervals of not more than five years. Thus, the National Framework was reviewed in 2012 which led to the development of 2012 National Framework for Air Quality Management in the Republic of South Africa. The Framework is revised every five years and the latest iteration of the Framework was promulgated in 2018 (National Environmental Management: Air Quality Act: 2017 National Framework for Air Quality Management in South Africa (Government Gazette No. 41996 (26 October 2018), Government Notice No. 1144).

Substantively, the most important aspects of the Framework are Chapters 3 and 5.

Chapter 3 deals with the responsibilities of inter alia industry, which include:

- Taking reasonable steps to prevent the emission of any offensive odour caused by any activity on their premises;
- Taking reasonable and effective steps to control dust from their activities;
- Compliance with any relevant standards for emissions from point, non-point or mobile sources in respect of substances or mixtures of substances identified by the Minister, member of the executive council or a municipality;
- Compliance with relevant emission standards in respect of controlled emitters if an activity undertaken by the industry and/or an appliance used by the industry is identified as a controlled emitter; and
- Compliance with the requirements of the regulations on emissions reporting developed under S12 of AQA.

Chapter 5 deals with problem identification and prioritisation and provides norms and standards for the setting of standards for ambient air quality, listed activities and emission standards, controlled emitters and controlled fuels. Chapter 5 further provides for Air Quality Management Plans, information on regulations, compliance and enforcement, air quality impact assessments and the linkages between the approval process for environmental impact assessments and application for an atmospheric emission licence (AEL).

Some of the notable differences from the 2012 version include:

- Less stringent requirement for postponements: it is sufficient for any applicant for an application for postponement of compliance with the minimum emission standards (MES) to simply show that the industry's air emissions are not causing direct adverse impacts on the surrounding environment. Under the 2012 version, an applicant had to show that, in addition to no adverse impacts currently being experienced, it will not cause any adverse impacts (5.4.3.4);
- Although Section 40 of AQA specifies timeframes within which decisions on AEL applications must be reached, it pertains only to new AEL applications. AQA does not regulate the timeframes within which licensing authorities must reach

decisions on the transfer, review, variation and renewal of AELs or provisional AELs. At present, licensing authorities have discretion in this regard. The Framework now provides specific timeframes (each varying between 30 and 90 days) for AEL issuance (with or without an environmental authorisation (EA)), renewal, review, or variation (with and without an emission increase);

- The Framework now expressly provides that an environmental management inspector (EMI) from the DEA may conduct compliance monitoring activities in any facility issued with an AEL, and that such EMI should inform and share the findings of the compliance with the licensing authority; and
- The Framework makes it clear that municipal Air Quality Officers (AQO) are also responsible for compliance monitoring for dust-generating activities, as contemplated in the National Dust Control Regulations, which regulations are due to be amended.

The Air Quality Act of South Africa is pivoted on the Bill of Rights contained in the Constitution of South Africa. The Bill enshrines the rights of all people in the country and affirms the democratic values of human dignity, equality and freedom. The state must respect, protect, promote and fulfil the rights in the Bill of Rights.

Section 24 of the Constitution states that everyone has the right:

- To an environment that is not harmful to their health or well-being; and
- To have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that –
- Prevent pollution and ecological degradation;
- Promote conservation; and
- Secure ecologically sustainable development and the use of natural resources while promoting justifiable economic and social development.

In order to give effect to this right in the context of air quality, it is necessary to ensure that levels of air pollution are not harmful to human health or well-being. It follows that the setting of ambient air quality standards is necessary, as well as mechanisms to ensure that ambient air quality standards are achieved and maintained. Hence, the AQA provides an objectives-based approach to the management of air quality at different governance and operational levels and is the legislative means to ensuring that the rights described above are upheld. Therefore, in implementing the AQA it is necessary to ensure that there is clarity on governance and technical objectives, so air quality management measures are implemented in a cohesive, coherent and uniform manner that ensures the most benefit for the least cost through efficient and effective use of resources.

The purpose of the National Framework is to achieve the objectives of the AQA, and as such the National Framework provides a medium- to a long-term plan of the practical implementation of the AQA.

The framework must provide mechanisms, systems and procedures to promote holistic and integrated air quality management through pollution prevention and minimisation at source, and through impact management with respect to the receiving environment from local scale to international issues. Hence, the National Framework provides norms and standards for all technical aspects of air quality management.

Section 7(1) of the AQA requires the National Framework to include the following:

- Mechanisms, systems and procedures to -
    - Attain compliance with ambient air quality standards;
    - Give effect to the Republic's obligations in terms of international agreements;

- National norms and standards for
    - The control of emissions from point and non-point sources;
    - Air quality monitoring;
    - Air quality management planning;
    - Air quality information management; and
- Any other matter which the Minister considers necessary for achieving the object of the AQA.

Section 7(2) of the AQA requires that the norms and standards established in the National Framework are aimed at ensuring:

- Opportunities for public participation in the protection and enhancement of air quality;
- Public access to air quality information;
- The prevention of air pollution and degradation of air quality;
- The reduction of discharges likely to impair air quality, including the reduction of air pollution at source;
- The promotion of efficient and effective air quality management;
- Effective air quality monitoring;

- Regular reporting on air quality; and
- Compliance with the Republic's obligations in terms of international agreements.

The National Framework, in terms of Section 7(3) of the AQA:

- Binds all organs of state in all spheres of government; and
- May assign and delineate responsibilities for the implementation of the AQA amongst:
    - The different spheres of government; and
    - Different organs of state.

## 2.2 National Environment Management: Air Quality Act

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 AQA serves to repeal the Atmospheric Pollution Prevention Act (45 of 1965) (APPA) and various other laws dealing with air pollution.

According to the Act, the then Department of Environment Affairs and Tourism (now the Department of Environment, Forestry and Fisheries) (DEFF), 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 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 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 air quality regulation, as reflected in the 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 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 License (AEL) in order to operate;
- 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 AQA, the Act provides for the government to turn down AEL Licence applications from applicants who have a problematic record of air quality management practices. It also provides for the government to demand that 'problem' industries appoint qualified air quality practitioners.

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[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 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 AQA.

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 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 Framework was published in September 2007 and under its provisions was amended in 2012 and published in 2013. The Framework was amended again in 2018.

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 a 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 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 Atmospheric Pollution Prevention Act (APPA) of 1965 was fully repealed on the same date.

The 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 AEL before they can operate. 1 April 2010 also marked the date when the new list of activities requiring AEL to operate was promulgated and, with this, the levelling of the atmospheric emission "playing field" through the setting of MES for all these listed activities were implemented.

Government Notice 248 (GN248:2010) established and identified activities that result in atmospheric emissions for which an AEL must be obtained before operation can take place. The Minister amended the list of activities in November 2013.

The amended list of activities was published in terms of Section 21(1)(b) of AQA as a 'list of activities that result in atmospheric emissions which have or may have a significant detrimental effect on the environment, including health, social conditions, economic conditions or cultural heritage' (GN893:2013, GG37054, 22 November 2013).

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 AEL needs to be obtained. The main categories include:

- Combustion Installations;
- Petroleum Industry, the production of gaseous ad liquid fuels as well as petrochemicals from crude oil, coal, gas or biomass;
- Carbonization and Platinum Gasification;
- Metallurgical Industry;
- Mineral Processing, Storage and Handling;
- Organic Chemicals Industry;
- Inorganic Chemicals Industry;
- Thermal Treatment of Hazardous and General Waste;
- Pulp and Paper Manufacturing Activities, including By-Products Recovery; and
- Animal Matter Processing.

The Notice further stated 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 the 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.

Any existing plant must comply with the minimum emission standards for the existing plant as contained in Part 3 of the Notice (which gives detailed account of minimum emission standards) by 01 April 2015 unless where specified. Any existing plant must comply with the minimum emission standards for the new plant as contained in Part 3 of the Notice (which gives a detailed account of minimum emission standards) by 01 April 2020, unless where specified.

The listed activities are published in terms of Section 21(1)(b) of AQA as a 'list of activities which result in atmospheric emissions which have or may have a significant detrimental effect on the environment, including health, social conditions, economic conditions or cultural heritage' (GN37054, 22 November 2013).

### 2.2.1 Legislation for Local Government

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

## 2.3 Relation to the Scoping and EIA Process

Through impact assessment, the safety, health and environmental impacts of developments and activities are scrutinised. This process encourages participation by all stakeholders and provides decision-makers with detailed information to determine whether an activity may proceed or not, and in the case of approval provides information on the mitigation measures that must be introduced to ensure that safety, health and environmental impacts are kept to acceptable levels.

Furthermore, environmental impact management has been rolled out nationally and provincially in the form of the environmental impact assessment (EIA) process. This participatory process provides the government with the detailed information required for it to make an informed decision on whether a development may go ahead or not, and, in the case of a go-ahead, exactly what measures must be taken to ensure that safety, health and environmental impacts are kept to acceptable levels.

The use and importance of the EIA tool is fully acknowledged by the AQA and, as such, the use of EIAs is inextricably linked to the AQA's atmospheric emission licensing process.

The requirements of the AQA interface with the EIA process in a number of ways that are addressed below. First, the process of granting an AEL is related to the issuing of an Environmental Authorisation (EA) for an EIA application as discussed in Paragraph 5.5.2 of NFAQM. Secondly, the AQA has introduced some fundamental changes to air quality legislation in South Africa that shape and inform the specialist Air Quality Impact Assessment reports, which generally form part of an EIA process. These latter aspects are considered below.

## 2.4 Reporting of Atmospheric Emissions

The National Atmospheric Emission Reporting Regulations (Government Gazette No. R283) came into effect on 2 April 2015.

The purpose of the regulations is to regulate the reporting of data and information from an identified point, non-point and mobile sources of atmospheric emissions to an internet-based National Atmospheric Emissions Inventory System (NAEIS), towards the compilation of atmospheric emission inventories. The NAEIS is a component of the South African Air Quality Information System (SAAQIS); its objective is to provide all stakeholders with relevant, up to date and accurate information on South Africa's emissions profile for informed decision making.

### 2.4.1 Classification of Emission Sources and Data Providers

Emission sources and data providers are classified according to groups A to D (listed in Table 4). According to Table 4, the Project would be classified under Group C ("Mines").

**Table 4: Emission source groups, associated data providers, emission reporting requirements and relevant authorities.**

| Group | Emission Source | Data Provider | NAEIS Reporting Requirements | Relevant Authority |
|---|---|---|---|---|
| **A** | Listed activity published in terms of section 21(1) of the Act. | Any person that undertakes a listed activity in terms of section 21(1) of the Act. | Emission reports must be made in the format required for NAEIS and should be in accordance with the atmospheric emission license or provisional atmospheric emission license. | Licensing authority. |
| **B** | Controlled emitter declared in terms of section 23(1) of the Act. | Any person that undertakes a listed activity in terms of section 21(1) of the Act and uses an appliance or conducts an activity that has been declared a controlled emitter in terms of section 23(1) of the Act.<br><br>Any relevant air quality officer receiving emission reports as contemplated under notice made in terms of section 23 of the Act. | Any information that is required to be reported in terms of the notice published in the Gazette in terms of section 23 of the Act. | The relevant air quality officer as contemplated under the notice made in terms of section 23 of the Act. |

| Group | Emission Source | Data Provider | NAEIS Reporting Requirements | Relevant Authority |
|---|---|---|---|---|
| C | Mines. | Any person, that holds a mining right or permit in term of the Mineral and Petroleum Resources Development Act, 2002 (Act 28 of 2002). | Emission reports must be made in the format required for NAEIS. | Relevant air quality officer. |
| D | Facilities identified in accordance with the applicable municipal by-law. | Any person that operates facilities which generate criteria pollutants and has been identified in accordance with the applicable municipal By-law. | Emission reports must be made in the format required for NAEIS. | Relevant air quality officer. |

### 2.4.2 Registration as Data Provider

The regulations specify that emission sources and data providers as classified in Table 4 must register on the NAEIS within 30 days from the date upon which these regulations came into effect.

Data providers must inform the relevant authority of changes if there are any:

- Change in registration details;
- Transfer of ownership; or
- Activities being discontinued.

### 2.4.3 Reporting or Submission of Information

A data provider must submit the required information for the **preceding calendar year** to the NAEIS by **31 March** of each year. Records of data submitted must be kept for a period of 5 years and must be made available for inspection by the relevant authority.

### 2.4.4 Verification of Information

The relevant authority must request, in writing, a data provider to verify the information submitted if the information is incomplete or incorrect. The data provider then has 60 days to verify the information. If the verified information is incorrect or incomplete the relevant authority must instruct a data provider, in writing, to submit supporting documentation prepared by an independent person. The relevant authority cannot be held liable for the cost of the verification of data.

### 2.4.5 Penalties

A person guilty of an offence in term of regulation 13 of these Regulations is liable in the case of a first conviction to a fine not exceeding R5 million or to imprisonment of a period not exceeding five years, and in the case of a second or subsequent conviction to a fine not exceeding R 10 million or imprisonment for a period not exceeding 10 years and in respect of both instances to both such imprisonment.

## 2.5 Specialist Air Quality Impact Assessment Report

In general, all development applications involving listed activities will be required to undergo an EIA process and will require a specialist Air Quality Impact Assessment study based on the type of development. Through its various requirements, the AQA prescribes and informs the scope and content of such specialist Air Quality Impact Assessment studies. The key elements of the AQA that are relevant to the EIA process are summarised, followed by the establishment of norms for a specialist AQIA report based on these requirements.

Key requirements of the AQA are as follows:

### 2.5.1 Human health impacts

One of the objectives of the AQA is to give effect to our constitutional right to an environment that is not harmful to the health and well-being of people. The emphasis on human health requires that the specialist AQIA for a proposed listed activity includes an assessment of potential health impacts. The level of detail required is dependent on the nature and extent of atmospheric emissions and could range from a simple comparative assessment of predicted ambient air quality levels with ambient air quality standards through to a full health risk assessment.

### 2.5.2 Ambient air quality standards

The AQA is effects-based legislation, with the result that activities that result in atmospheric emissions are to be determined with the objective of achieving health-based ambient air quality standards (Table 5). Each new development proposal with potential impacts on air quality must be assessed not only in terms of its individual contribution, but in terms of its additive contribution to baseline ambient air quality i.e. cumulative effects must be considered.

### 2.5.3 Point source emission standards

The AQA may also prescribe minimum standards for certain point source emissions and these must be considered in the specialist study.

### 2.5.4 Mitigation measures

Related to the above, the AQA states that the Best Practicable Environmental Option (BPEO) that would prevent, control, abate or mitigate pollution, must be used.

## 2.6 Ambient Air Quality Standards

**Table 5: National Ambient Air Quality Standards as of 24 December 2009.**

| National Ambient Air Quality Standards 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 Standards 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 Standards for Particulate Matter ($PM_{10}$) | | | |
|---|---|---|---|
| AVERAGING PERIOD | LIMIT VALUE ($\mu g/m^3$) | FREQUENCY OF EXCEEDANCE | COMPLIANCE DATE |
| 24 hours | 120 | 4 | Immediate – 31 December 2014 |
| 24 hours | 75 | 4 | 1 January 2015 |
| 1 year | 50 | 0 | Immediate – 31 December 2014 |
| 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 Standards 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 Standards for Benzene ($C_6H_6$) | | | | |
|---|---|---|---|---|
| AVERAGING PERIOD | LIMIT VALUE (µg/m³) | LIMIT VALUE (ppb) | FREQUENCY OF EXCEEDANCE | COMPLIANCE DATE |
| 1 year | 10 | 3.2 | 0 | Immediate – 31 December 2014 |
| 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 (µg/m³) | 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 Standards for Carbon Monoxide (CO)** | | | | |
| AVERAGING PERIOD | LIMIT VALUE (mg/m³) | LIMIT VALUE (ppm) | FREQUENCY OF EXCEEDANCE | COMPLIANCE DATE |
| 1 hour | 30 | 26 | 88 | Immediate |
| 8 hours (calculated on 1 hourly averages) | 10 | 8.7 | 11 | Immediate |
| The reference method for analysis of CO shall be ISO 4224. | | | | |

The DEA has established National Ambient Air Quality Standards for particulate matter of aerodynamic diameter less than 2.5-micron metres in June 2012 (GN486: 2012) as depicted in Table 6.

**Table 6: Established National Ambient Air Quality Standards for Particulate Matter ($PM_{2.5}$).**

| National Ambient Air Quality Standards for Particulate Matter ($PM_{2.5}$) | | | |
|---|---|---|---|
| AVERAGING PERIOD | LIMIT VALUE (µg/m³) | FREQUENCY OF EXCEEDANCE | COMPLIANCE DATE |
| 24 hours | 65 | 4 | Immediate – 31 December 2015 |
| 24 hours | 40 | 4 | 1 January 2016 – 31 December 2029 |
| 24 hours | 25 | 4 | 01 January 2030 |
| 1 year | 25 | 0 | Immediate – 31 December 2015 |
| 1 year | 20 | 0 | 1 January 2016 – 31 December 2029 |
| 1 year | 15 | 0 | 01 January 2030 |
| The reference method for the determination of $PM_{2.5}$ fraction of suspended particulate matter shall be EN 14907. | | | |

## 2.7 Dust Deposition Standards

In November 2013 DEA published the National Dust Control Regulations (NDCR) (GN36974:2013) in terms of Section 53(o) of AQA, read with Section 32, which relate to the prescription of general measures for the control of dust in all areas and establish dust fall limits for residential and non - residential areas.

The established standard is as follows:

- 600 mg/m$^2$/day averaged over 30 days in residential areas measured using reference method ASTM D1739; or
- 1200 mg/m$^2$/day averaged over 30 days in non-residential areas measured using reference method ASTM D1739.

The National Dust fallout standard is given in the Table 7 below.

**Table 7: Acceptable dust fall rates as measured (using ASTM D1739:1970 or equivalent) at and beyond the boundary of premises where dust originates.**

| 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 |

Any person who has exceeded the dust fallout standard must, within three months after submission of a dust fallout monitoring report, develop and submit a dust management plan to the air quality officer for approval. The dust management plan must:

a) Identify all possible sources of dust within the affected site;
b) Detail the best practicable measures to be undertaken to mitigate dust emissions;
c) Develop and implementation schedule;
d) Identify the line management responsible for implementation;
e) Incorporate the dust fallout monitoring plan; and
f) Establish a register for recording all complaints received by the person regarding dust fall, and for recording follow up actions and responses to the complainants.

The dust management plan must be implemented within a month of the date of approval. An implementation progress report must be submitted to the air quality officer at agreed time intervals.

## 2.8 Regulations Regarding Air Dispersion Modelling

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

a) In the development of an air quality management plan, as contemplated in Chapter 3 of the NEM: AQA;
b) In the development of a priority area air quality management plan, as contemplated in Section 19 of the NEM: AQA;
c) In the development of an atmospheric impact report, as contemplated in Section 30 of the NEM: AQA; and,
d) In the development of a specialist air quality impact assessment study, as contemplated in Chapter 5 of the NEM: AQA.

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

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

Dispersion modelling provides a versatile means of assessing various emission options for the management of emissions from existing or proposed installations. Chapter 3 of the Regulation prescribe the source data input to be used in the model. Dispersion models are particularly useful under circumstances where the maximum ambient concentration approaches the ambient air quality limit value and provide a means for establishing the preferred combination of mitigation measures that may be required.

Chapter 4 of the Regulation prescribe meteorological data input from on-site observations to simulated meteorological data. The chapter also gives information on how missing data and calm conditions are to be treated in modelling applications. Meteorology is fundamental for the dispersion of pollutants because it is the primary factor determining the diluting effect of the atmosphere.

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

The modelling domain would normally be decided on the expected zone of influence; the extent being defined by simulated ground level concentrations from initial model runs. The modelling domain must include all areas where the ground level concentration is significant when compared to the air quality limit value (or other guideline). Air dispersion models require a receptor grid at which ground-level concentrations can be calculated. The receptor grid size should include the entire modelling domain to ensure that the maximum ground-level concentration is captured and the grid resolution (distance between grid points) sufficiently small to ensure that areas of maximum impact adequately covered.

Chapter 5 provides general guidance on geophysical data, model domain and coordinates system requirements, whereas Chapter 6 elaborates more on these parameters as well as the inclusion of background air pollutant concentration data. Chapter 6 also provides guidance on the treatment of $NO_2$ formation from $NO_x$ emissions, chemical transformation of $SO_2$ into sulphates and deposition processes. Chapter 7 of the Regulation outlines how the plan of study and modelling assessment reports are to be presented to authorities.

## 2.9 Air Quality Management Plans

With the shift of the new Air Quality Act from source control to the impacts on the receiving environment, the responsibility to achieve and manage sustainable development has reached a new dimension. The Air Quality Act has placed the responsibility of air quality management on the shoulders of provincial and local authorities that will be tasked with baseline characterisation, management and operation of ambient monitoring networks, licensing of listed activities, and emissions reduction strategies. The main objective of the act is to ensure the protection of the environment and human health through reasonable measures of air pollution control within the sustainable (economic, social and ecological) development framework.

### 2.9.1 North West Province Air Quality Management Plan

The Air Quality Management Plan for North West Province was developed in February 2009 by Bembani Sustainability Training (Pty) Ltd. It is a high level plan that did not delve into details of sources of air pollution. The emissions inventory identified the following (excerpts from the Plan):

"An Air Quality Management Plan for the Rustenburg Local Municipality in the Bojanala Platinum District Municipality was developed in 2006. The plan did however not include an emissions inventory for the region. The last comprehensive emissions inventory compiled for the Rustenburg / Brits region was done in 2001 (Sowden and Burger, 2001).

- A source inventory was compiled based on the NW Cleaner Air Report 2008. This was limited to improvements made on industrial and mining operations carrying out registered scheduled processes.
- Smaller Industrial and boiler operations data was based on the Rustenburg AQMP, as well as data collection and gathering conducted in all districts during August 2008. Some of the information provided could not be verified as no ground truths were carried out.
- Various mines are operational within the North West Province from large scale platinum, chrome and vanadium mining to small scale clay and diamond mining. The types of mines and locations were provided by the Department of Mineral and Energy (DME) for the year 2006. Some emission rates for some of the mines are contained in the Cleaner Air Report 2008. However, there are still gaps as these cover only those operations that have made improvements in air quality in the past years (with 2000 being the base year). Similarly the locations of tailings dams are known but with no emissions data.
- Population statistics and domestic fuel usage data were based on the 2001 Census data and 2007 Statistics South Africa Community Survey Reports. This indicated that fairly large portions of the rural communities are still reliant on coal, wood and paraffin for dual-use. Emissions from these fuel sources are a concern and need to be addressed. The most recent emissions data quantified for these sources are the 2001 emissions inventory but only covers the Bojanala Platinum

District Municipality.

- Biomass burning is a significant source for the periods when it occurs. Again the most recent emissions data available are the 2001 emissions inventory. These emissions should however not change significantly even though the areas affected by it may.

- Vehicle tailpipe emissions are a significant source of $NO_2$ in regions close to busy roads and intersections. An emissions inventory was compiled during the Environmental Impact Assessment (EIA) conducted for the Bakwena Platinum Highway between Bela-Bela and Botswana. These emissions were however based on the old fuel specifications (i.e. including leaded petrol and high sulphur content in the diesel). Thus, it is expected that certain emissions would have been reduced. Also, the actual traffic volumes might differ significantly from the projections used in the study.

- The landfill site data was provided by the Department of Water Affairs and Forestry. However, no emissions data exist for the landfill sites in the North West Province. Information for the medical waste incinerators was based on the 1994 DEAT database and was verified (where possible) during the data gathering and verification processes in August 2008. These need to be updated.

- Crop farming and cattle farms are also potential significant sources of fugitive emissions. Odours and VOCs are also associated with animal manure. No emissions data exist for these sources."

Gap analysis performed during the compilation of AQMP established a number of gaps during the compilation of AQMP Report. These include:

- No comprehensive current emissions inventory for the North West Province. Emissions data available for varying sources and for different time periods.

- Limited vehicle counts and data. Typically vehicle counts are limited to very specific areas and on busy roads. Fuel sales are provided per District Municipality.

- Unavailability of data for certain SAWS weather stations.

- Ambient air quality data is limited to the main industrial areas (i.e. Brits and Rustenburg), with no ambient data for the other industrial and mining areas, and rural areas. The ambient monitoring is mainly restricted to particulates ($PM_{10}$) and sulphur dioxide ($SO_2$) concentrations and dust fallout data;

- Limited capacity in the various spheres of Government on air quality management. Poor response to questionnaires on capacity assessment has led to unknown status of capacity to execute air quality management functions within the district and local municipalities.

- Conflicting information on the status of medical waste incineration facilities in the Province. The gaps in the data collection and verification report need to be addressed before the completion of the PAQMP.

# 3. DESCRIPTION OF THE RECEIVING ENVIRONMENT

## 3.1 Project Location

Farm Gestoptefontein 349 IO and Driekuil 280 IP are situated within the Local Municipality of Tswaing, within the Ngaka Modiri Molema District Municipality in North West Province, some 55 km west of Delareyville along the Regional Route R507 which starts at N18 at Setlagole between Stella and Mmabatho, crosses N14 in Delareyville, past R506, through Ottosdal: crosses R505 in Ottosdal, staggered crosses R503 (1.6 km) through Hartbeesfontein, and ends at R30 at Brakspruit, 24 km north of Klerksdorp. Current mine layout is depicted in Figure 7, while the poroposed expansion activities are shown in Figure 8.

Project location details are given in Table 8.

**Table 8: Summary of Project Location Details: Wonderstone Ltd Project.**

| | |
|---|---|
| **Province** | North West |
| **District Municipality** | Ngaka Modiri Molema |
| **Local Municipality** | Tswaing Local Municipality |
| **Nearest Town** | Ottosdal |
| **AEL number** | N/A |
| **Mining Right** | Converted: NW30/5/1/2/2/397MR<br>New order: NW30/5/1/2/2/398MR |
| **Applicant** | Wonderstone Ltd (Pty) Ltd |
| **Co-ordinates** | 26°44'3.42"S<br>25°59'8.38"E |
| **Property Name** | Farm Driekuil 280 IP<br>Farm Gestoptefontein 349 IO |
| **Property SG Code** | T0IP00000000028000000<br>T0IO00000000034900000 |
| **Designated Air Quality Priority Area** | N/A |

## 3.2 Sensitive Receptors in terms of Air Quality

Sensitive receptors (SRs) primarily refer to places where humans reside, schools and hospitals. Ambient air quality guidelines and standards, as discussed under Section 2, have been developed to protect human health. Ambient air quality, in contrast to occupational exposure, pertains to areas outside of an industrial site boundary where the public has access to and according to the Air Quality Act, excludes areas regulated under the Occupational Health and Safety Act (Act No 85 of 1993).

For air quality impact assessment, the schools, clinics, hospitals and old age homes within the modelling domain are the primary sensitive receptors. There are seven schools, no old age homes, two clinics and no hospitals that were identified within the modelling domain (Table 9 and Figure 9). There are two residential areas: Letsopa 17,488 inhabitants and Ottosdal 884 inhabitants (see Table 10 and Figure 10) and the modelling domain encompasses parts of Wards 11, 12 and 13 of the Tswaing Local Municipality, which, according to the 2011 Census, account for 7,598 inhabitants and 2,216 households.

**Table 9: Potential primary sensitive receptors (schools, health facilities and old age home) situated within the modelling domain of Wonderstone Ltd Project.**

| Receptor | Latitude (°S) | Longitude (°E) | Direction from Site Boundary | Distance from Site Boundary (km) |
|---|---|---|---|---|
| CVO Ottosdal School | 26.81265 | 26.00311 | SSE | 8.5 |
| Laerskool Ottosdal | 26.80896 | 26.00054 | SSE | 8.1 |
| Lebogang Primary School | 26.79876 | 25.98955 | SSW | 7.1 |
| Leretletse Lesedi High School | 26.80657 | 25.97896 | SSW | 8.1 |
| Letsopa Primary School | 26.80683 | 25.98560 | SSW | 8.0 |
| Naledi Primary School | 26.80245 | 25.97804 | SSW | 7.7 |
| Natanja Christian School | 26.80825 | 26.01217 | SSE | 8.2 |
| Realeka Secondary School | 26.80432 | 25.97486 | SSW | 7.9 |
| Tumisang Primary School | 26.80178 | 25.98581 | SSW | 7.4 |
| Ottosdal Health Centre | 26.81378 | 26.00874 | SSE | 8.7 |
| Ottosdal Hospital | 26.81012 | 26.00386 | SSE | 8.3 |
| Ottosdal Municipal Clinic | 26.81387 | 25.99968 | S | 8.7 |
| Ottosdal Old Age Home | 26.80979 | 26.00760 | SSE | 8.3 |

**Table 10: Potential sensitive receptors – residential areas and farms, situated within the modelling domain of Wonderstone Ltd Project.**

| Receptor | Latitude (°S) | Longitude (°E) | Direction from Site Boundary | Distance from Site Boundary (km) |
|---|---|---|---|---|
| Farm 1 | 26.6993 | 25.95497 | NW | 5.7 |
| Farm 2 | 26.71119 | 25.96383 | NW | 4.2 |
| Farm 3 | 26.71203 | 25.98257 | NNW | 2.9 |
| Farm 4 | 26.72043 | 25.97631 | NNW | 2.6 |
| Farm 5 | 26.73418 | 25.94489 | W | 5.1 |
| Farm 6 | 26.75801 | 25.96675 | SW | 3.8 |
| Farm 7 | 26.76541 | 25.93181 | SW | 7.2 |
| Farm 8 | 26.77474 | 25.93782 | SW | 7.3 |

| Receptor | Latitude (°S) | Longitude (°E) | Direction from Site Boundary | Distance from Site Boundary (km) |
|---|---|---|---|---|
| Farm 9 | 26.78657 | 25.9595 | SSW | 6.7 |
| Farm 10 | 26.782 | 26.00422 | S | 5.1 |
| Farm 11 | 26.79445 | 26.02336 | SSE | 7.0 |
| Farm 12 | 26.78669 | 26.06095 | SE | 8.5 |
| Farm 13 | 26.77534 | 26.03581 | SE | 5.8 |
| Farm 14 | 26.76844 | 26.03111 | SE | 5.0 |
| Farm 15 | 26.70431 | 26.05198 | NE | 6.5 |

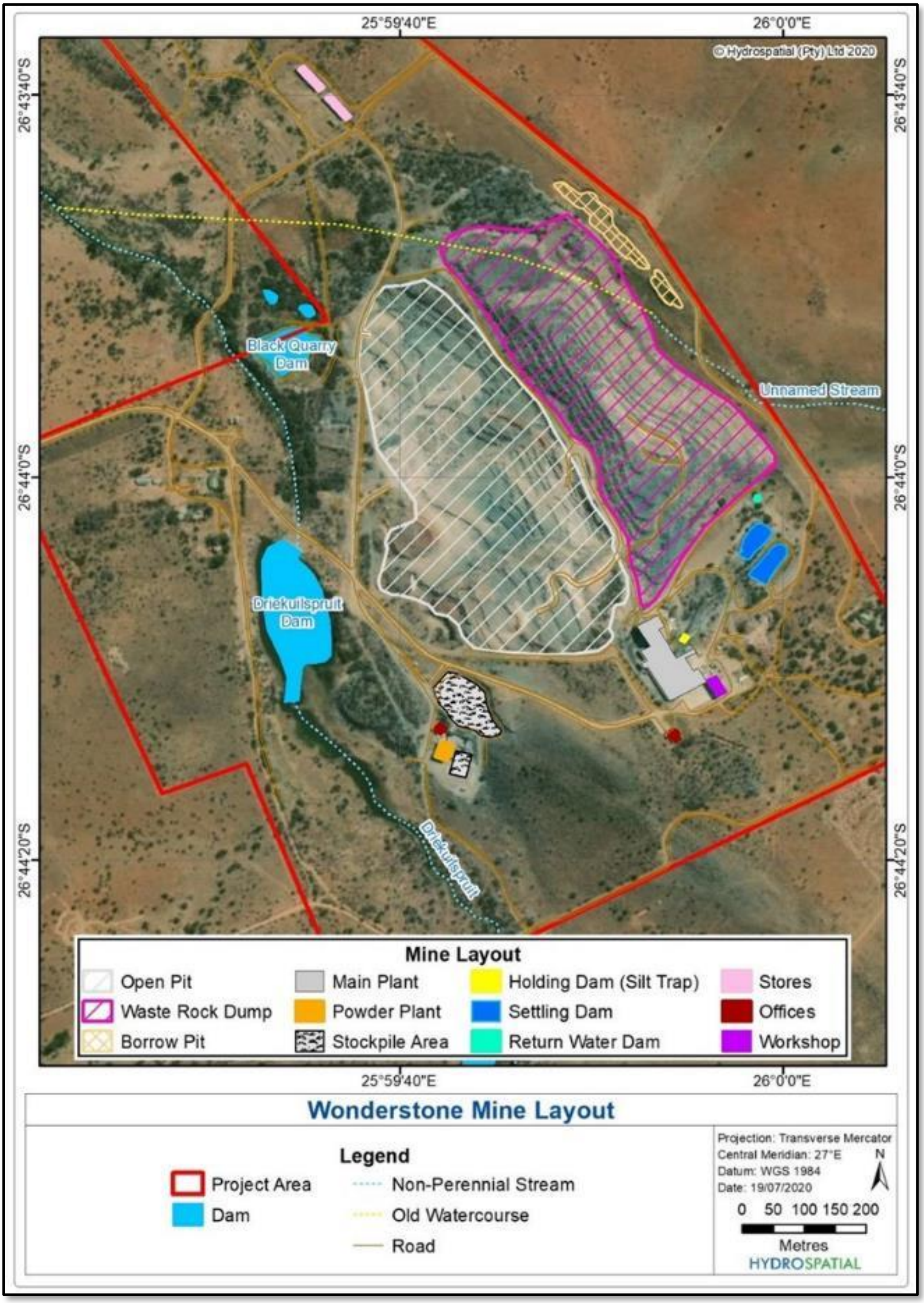


**Figure 7: Wonderstone Ltd Project current mine layout (EnviroGistics, 2021).**

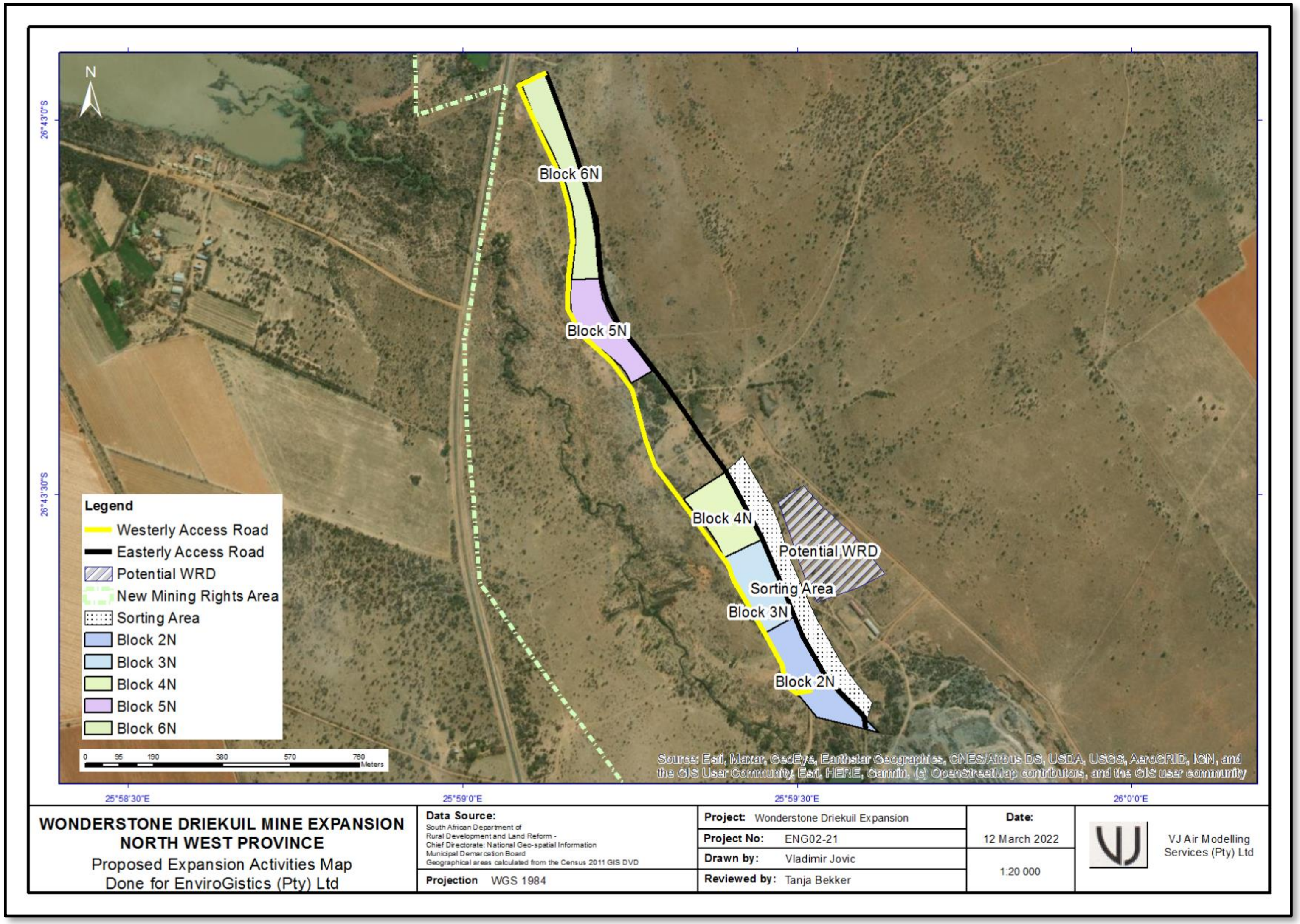


**Figure 8: Proposed expansion activities at the Wonderstone Ltd Project area.**

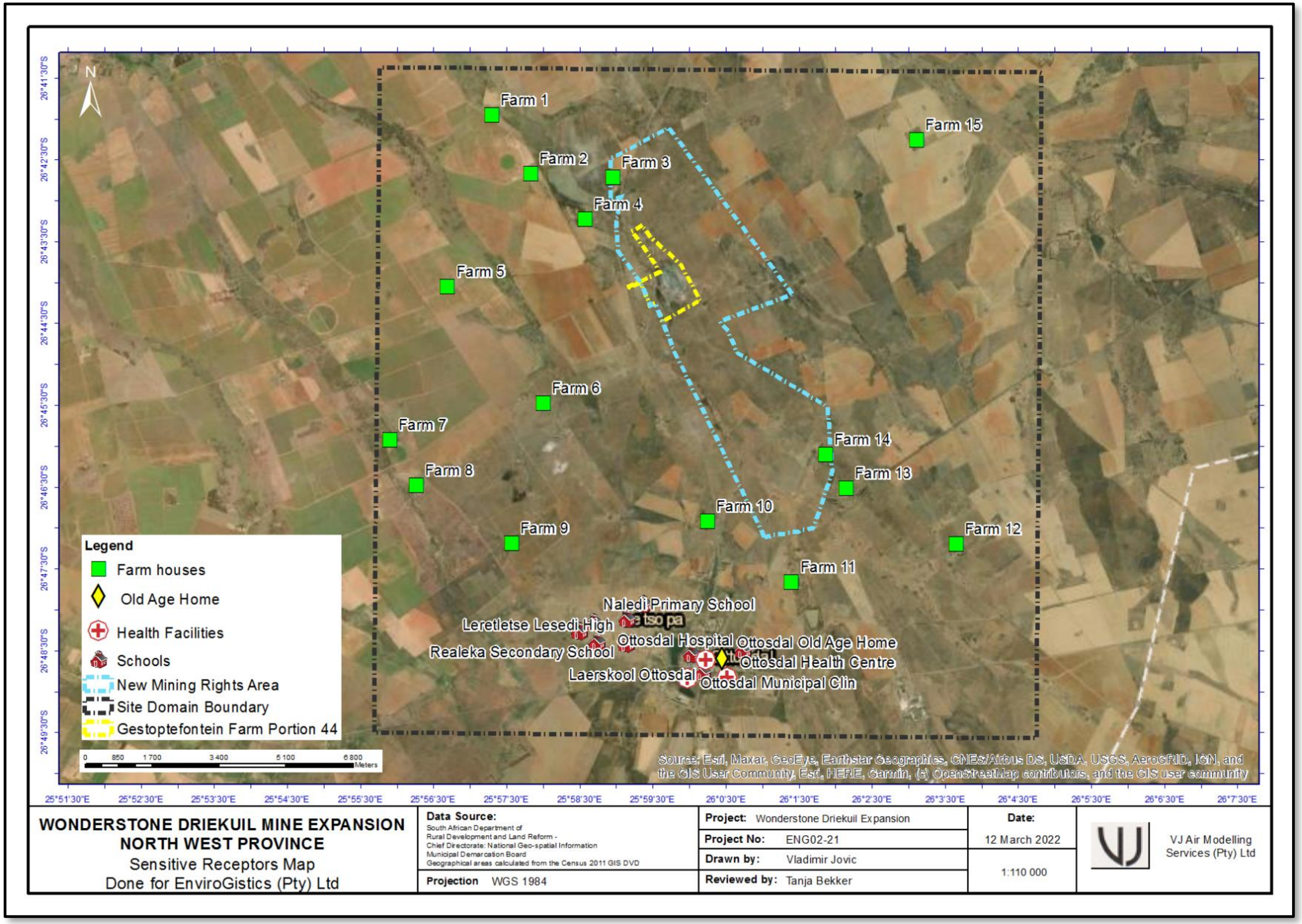


**Figure 9: Sensitive receptors surrounding the Wonderstone Ltd Project area.**

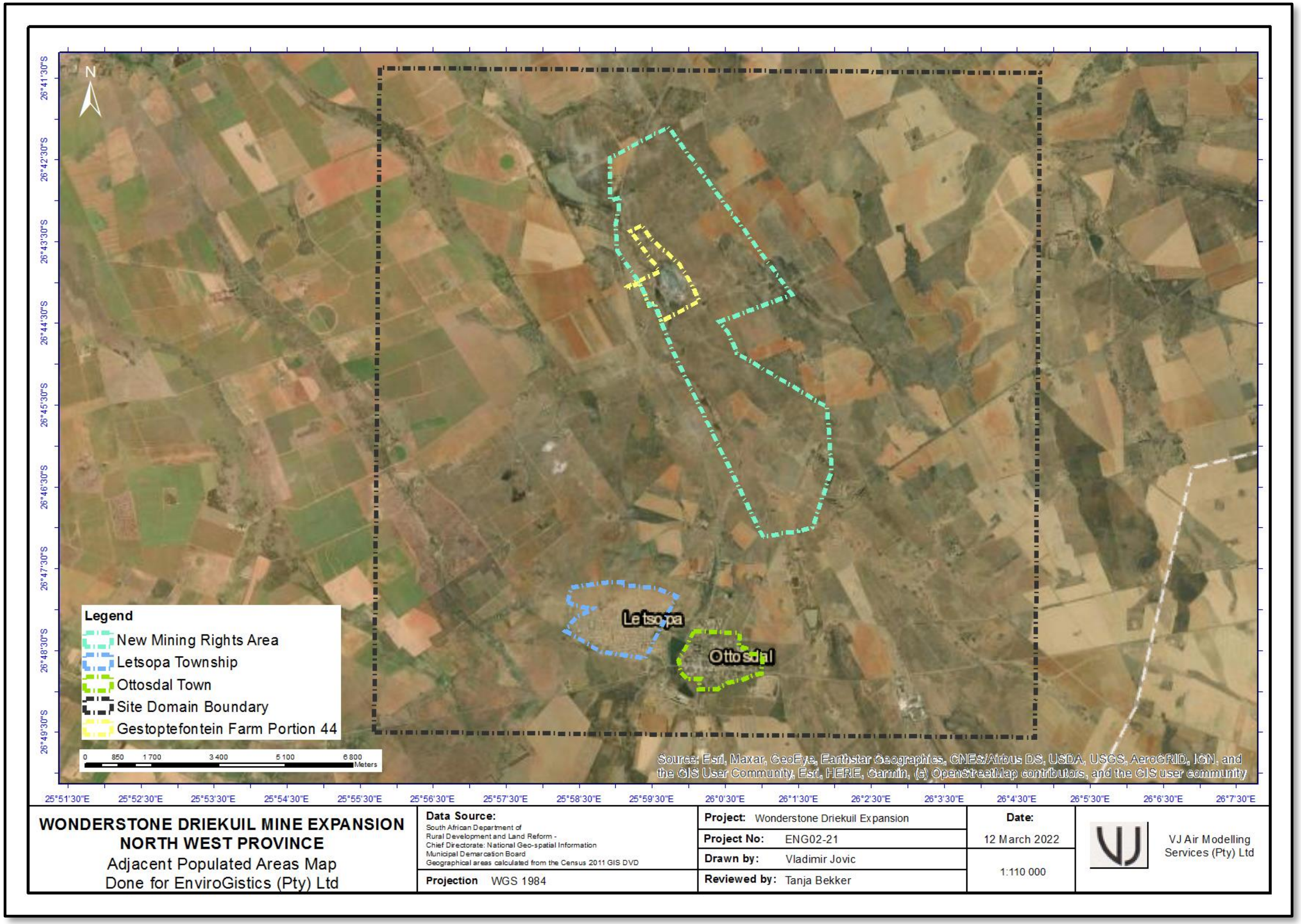


**Figure 10: Potential sensitive receptors – adjacent populated areas situated within the modelling domain of Wonderstone Ltd Project area.**

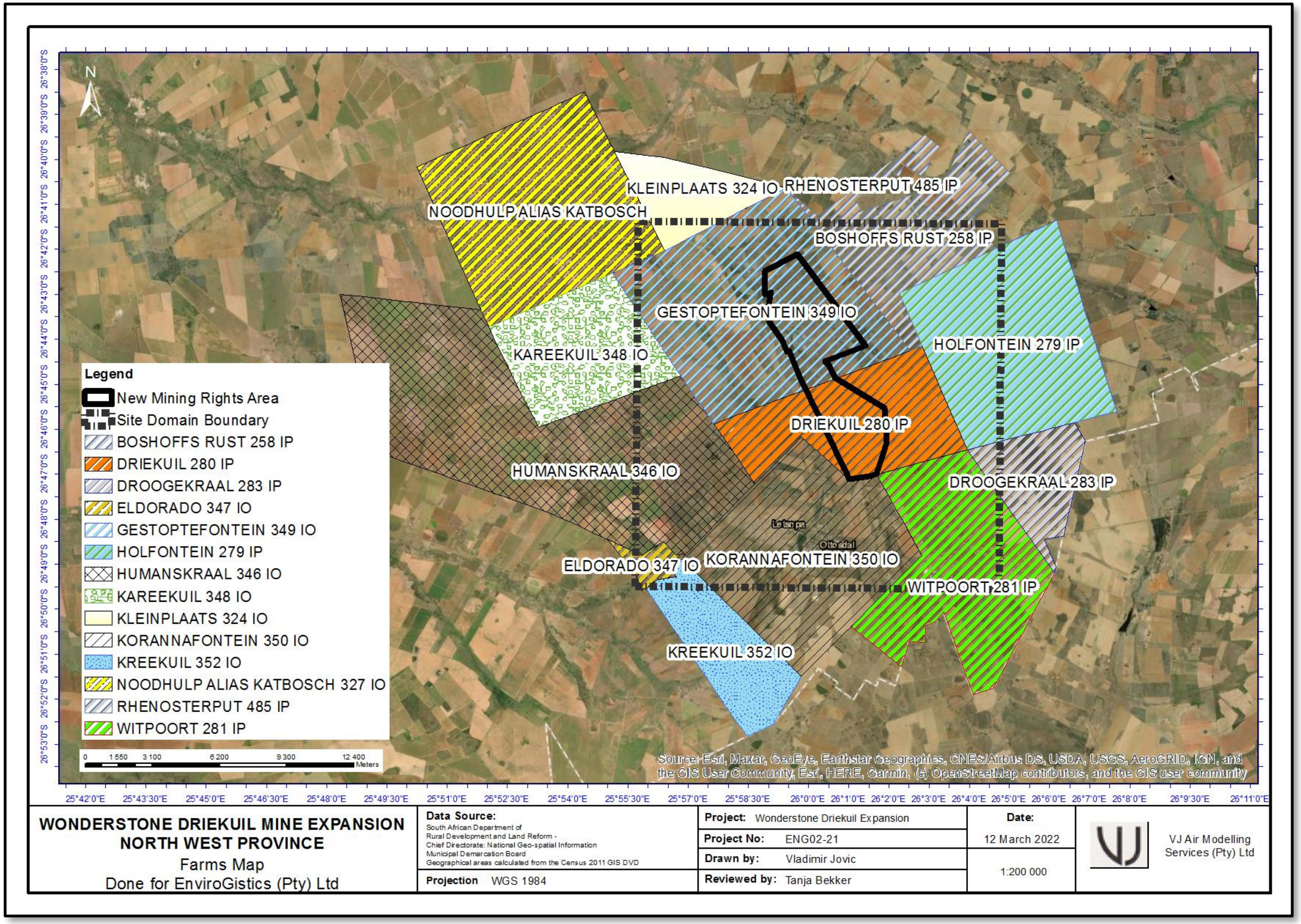


**Figure 11: Potential sensitive receptors – adjacent farms situated within the modelling domain of Wonderstone Ltd Project area.**

## 3.3 Atmospheric Dispersion Potential

Physical and meteorological mechanisms govern the dispersion, transformation, and eventual removal of pollutants from the atmosphere. The analysis of hourly average meteorological data is necessary to facilitate a comprehensive understanding of the dispersion potential of the site. Parameters useful in describing the dispersion and dilution potential of the site i.e. wind speed, wind direction, temperature and atmospheric stability, are subsequently discussed. Hourly meteorological data from the WRF data set was extracted for the site. This data has been tested extensively and has been found to be extremely accurate.

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).

### 3.3.1 Topography

Changes in terrain around an air pollution source can significantly influence the way the plume is dispersed. Hills or rough terrain influence the wind speed, wind direction and turbulence characteristics. Significant valleys can cause persistent drainage flows and restrict horizontal movement, whereas sloping terrain may help provide katabatic or anabatic flows.

The topography of Wonderstone Ltd area is defined as flat, lightly undulating terrain, with only prominent features the outcrops of wonderstone that follow southeast-northwest direction. The project site is relatively flat, at an average elevation of 1,470 metres above mean sea level (mamsl), with various perennial and non-perennial drainage lines crossing the site and artificial dams that drain towards east (Klein-Hartsrivier). The topographic relief can be described as relatively gently sloping towards the west, while the topographic elevation varies between approximately 1,400 mamsl in the west of the project site to 1,570 mamsl in the far east and south east.

The modelling domain encompasses the area that varies between 1,397 mamsl to 1,566 mamsl. An analysis of topographical data did not indicate a slope of more than 1:10 over the proposed modelling area. Dispersion modelling guidance recommends the inclusion of topographical data in dispersion simulations in areas where the slope exceeds 1:10 (US EPA, 2004) (Figure 12).

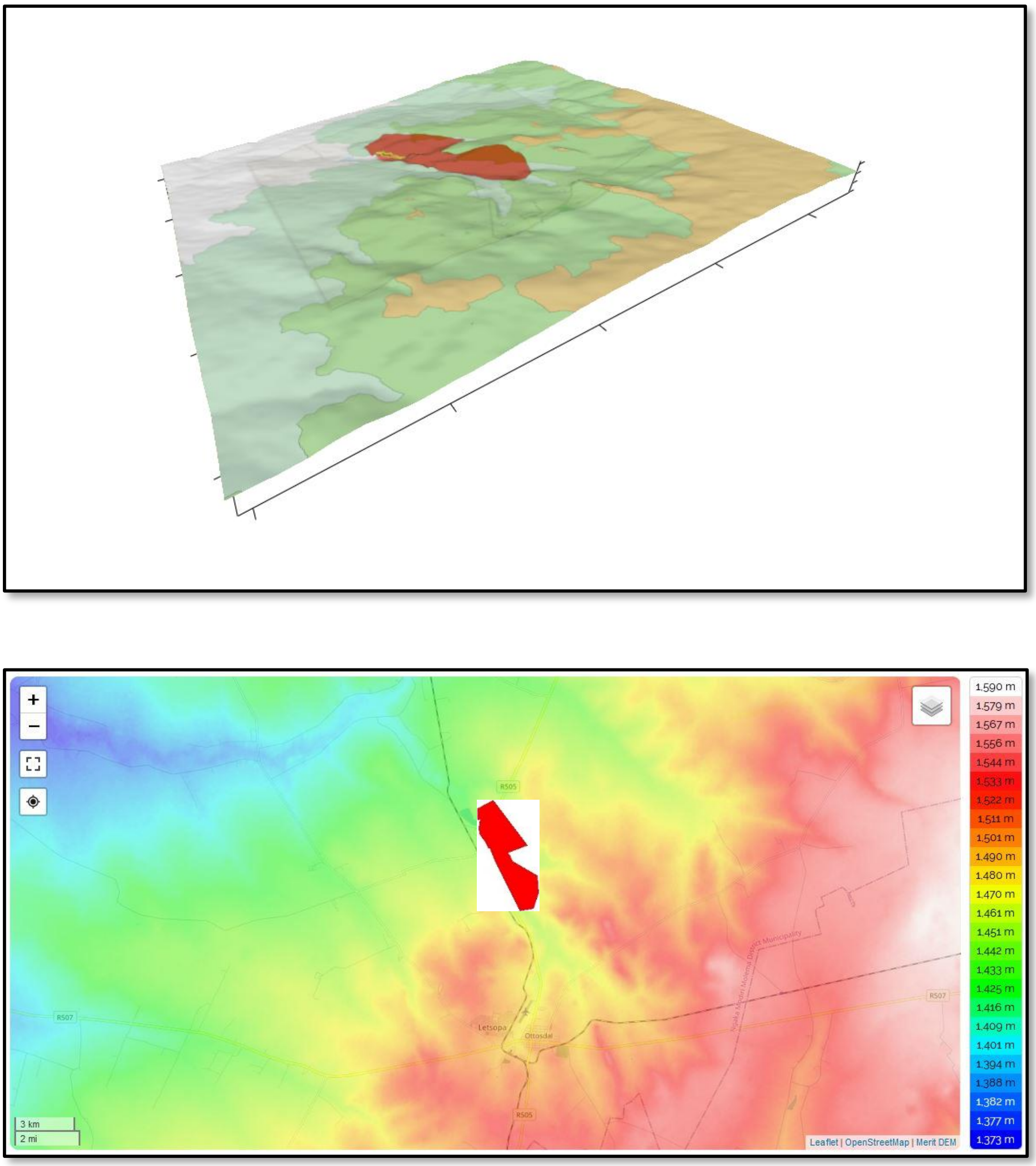


**Figure 12: Topography of the study area. 3D Scene exported from the AERMOD View modelling software (above, new mining rights area presented as dark red polygon). Wonderstone Ltd new mining rights area is presented as red polygon in the centre of the map (below) (Adapted from the "Free topographic maps visualization and sharing website", https://en-za.topographic-map.com/maps/9wvt/Bloemhof-Dam-Nature-Reserve/ accessed 01 December 2021).**

### 3.3.2 Land Use

The Wonderstone Ltd Project primary area is situated on the Gestoptefontein 349 IO farm, approximately 9 km to the north of the Ottosdal. The main road providing access to Wonderstone Ltd Project area is by R505 Regional Route.

In terms of land use, the project area is rural in nature, with agricultural land use dominating the surroundings. Commercial annual crops (rain-fed and pivot irrigated), fallow lands and old fields (grass and bush), natural grassland, low shrub land, herbaceous wetlands and contiguous forests are the main land use categories that are represented in the vicinity of project area, with mining activity situated approximately 11.5 km to the southeast of Wonderstone, along the same outcrop (Figure 13).

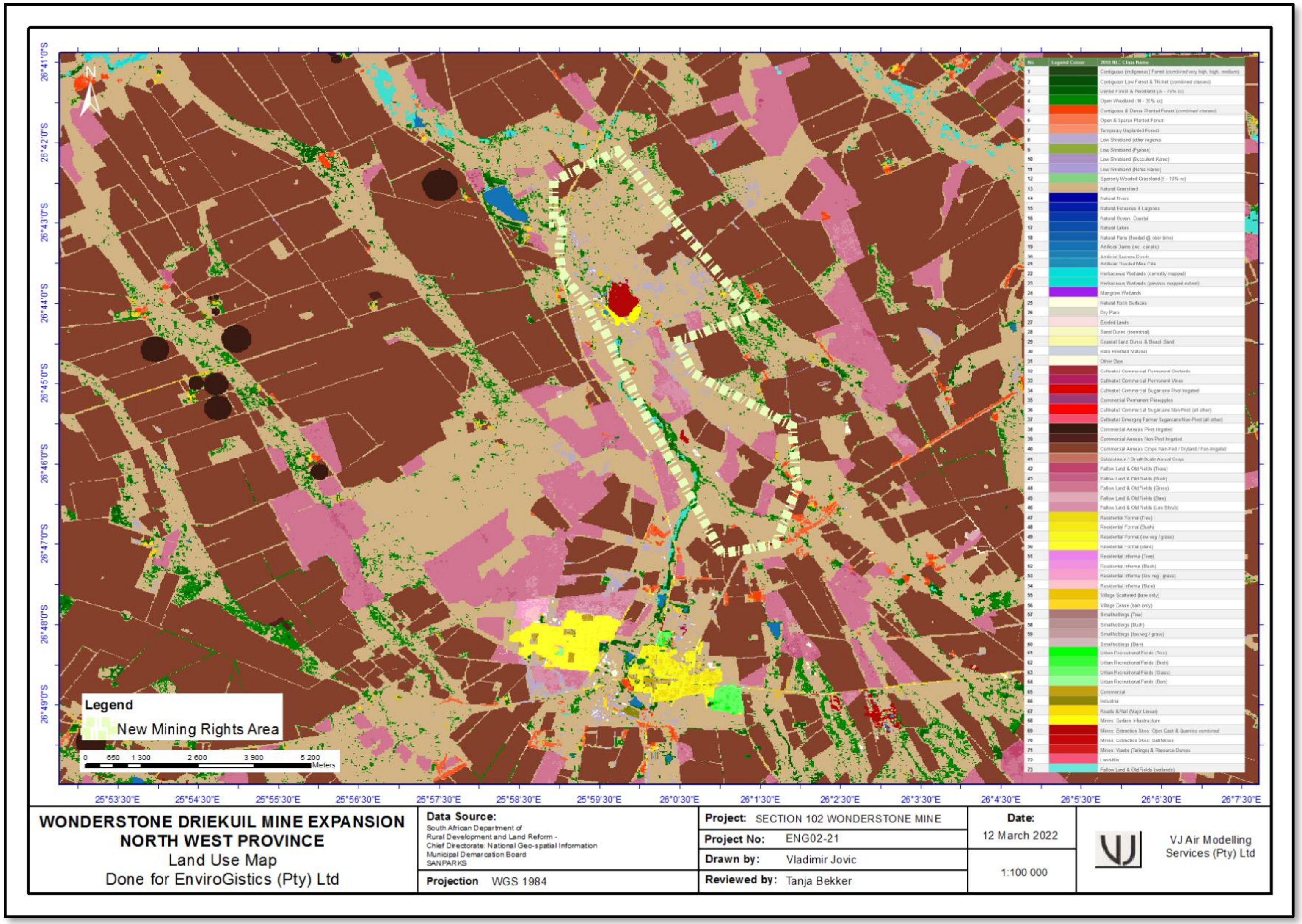


**Figure 13: Map of the Land Use of the study site.**

### 3.3.2 Meteorological Overview

The horizontal dispersion of pollution is largely a function of the wind field. The wind speed determines both the distance of downwind 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.

To provide insights into prevailing meteorological conditions in the area, meteorological data was obtained from the Agricultural Research Council (ARC) Ottosdal meteorological station for the period January 2017 – December 2019. This station is located approximately 10 km northwest of Wonderstone. Given the gently undulating terrain characteristics of the area, data measured at this station is assumed to be representative of conditions experienced at Wonderstone. Data recovery for wind direction and wind speed, as well as temperature is given in Table 11.

**Table 11: Data recovery from the ARC Ottosdal meteorological for the period January 2017 – December 2019.**

| Parameter | Data recovery (%) |
|---|---|
| Wind | 100 |
| Temperature | 100 |

### 3.3.3 Temperature and Rainfall

Air temperature in any pollutant study is important for assessing the effects of plume buoyancy as well as the development of inversion and mixing layers, while rainfall is an important pollutant removal mechanism especially in the case of particulate matter. Air temperature provides an indication of the extent of insolation, and therefore of the rate of development and dissipation of mixing dispersion layers. Figure 14 presents the average temperature, temperature range and total daily rainfall recorded at the Ottosdal station for the 2017 to 2019 period.

Clear seasonal variations are evident in the temperature and rainfall values for the area. The region typically receives higher levels of rainfall during the summer months, coinciding with elevated temperatures, with highest rainfall recorded during February 2017. Temperatures in winter are cold, with a minimum below 0°C often being recorded.

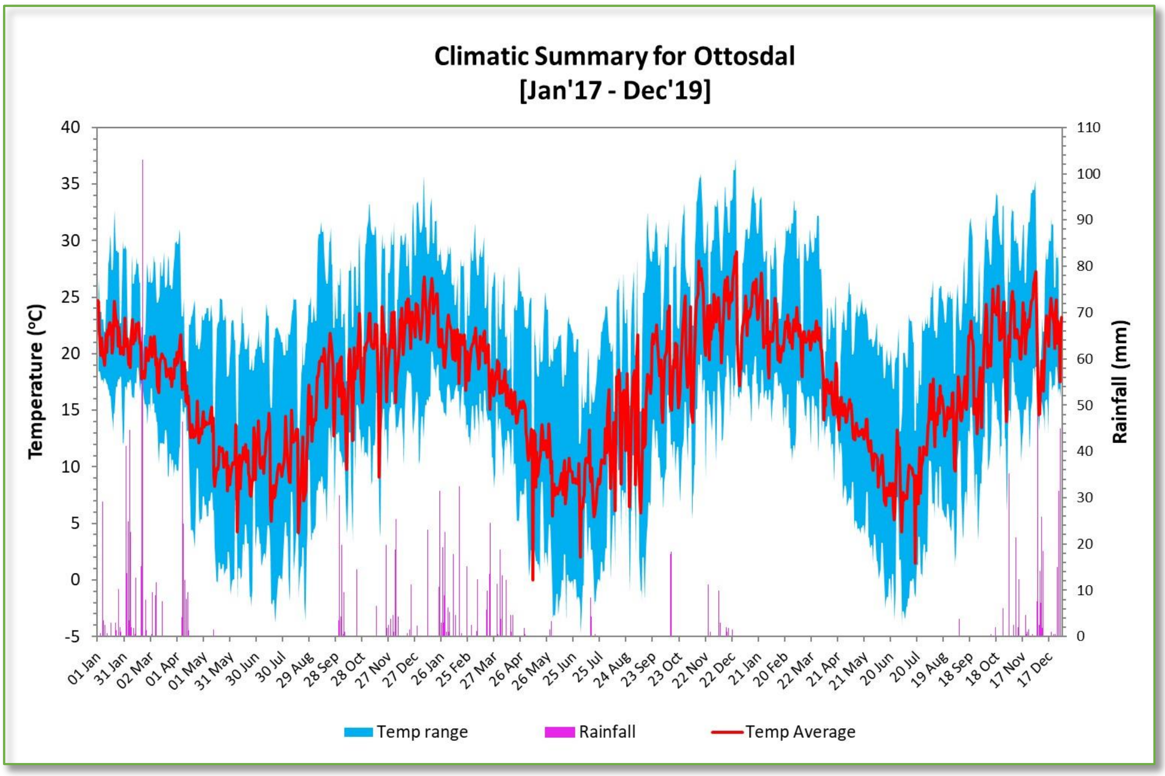


**Figure 14: Climate summary for Ottosdal (Agricultural Research Council Meteorological Station near Ottosdal - data 01 January 2017 – 31 December 2019) (adapted from the WSP Environmental Report: 41102258 EnviroGistics Wonderstone Mine Desktop AQ_2020 10 27.pdf).**

Wind roses are useful for illustrating the prevailing meteorological conditions of an area, indicating wind speeds and directional frequency distributions. In the following wind roses, the colour of the bar indicates the wind speed while the length of the bar represents the frequency of winds blowing from a certain direction (as a percentage).

The period surface wind rose plot from the Ottosdal meteorological station is presented in Figure 15. Winds recorded in the area originate predominantly from the north and east, with smaller north-easterly and north- westerly components. Wind speeds are moderate, with a number of winds exceeding 8 m/s, particularly from the north and north-northeast. Calm conditions (wind speeds < 1 m/s) are experienced 46.6% of the time.

Seasonal variations in winds are depicted in Figure 16. During summer (December to February) winds originate predominantly from the northerly and easterly directions, with few winds originating from the west and south. Fast winds are recorded during this time, often exceeding 8 m/s. During autumn (March to May), winds from the north and east continue to dominate, with the low frequency of winds from the west and south continuing. However, wind speeds show a marked decrease, with winds seldom exceeding 6 m/s, with a high number of calm periods occurring (63%). During winter (June to August) a noticeable decrease in winds originating from the north is observed, with winds dominating from the east. Wind speeds remain slow, with fastest winds continuing to originate from the north, although now at lower frequencies. During spring, (September to November) wind patterns return to those observed in summer, with winds predominantly originating from the northerly and easterly sectors, with an increase in winds, with spring experiencing fastest winds.

Diurnal variations in winds are depicted in Figure 17. During the early morning (00:00 – 06:00), winds originate predominantly from the east. During this time, winds are much gentler than during the daytime hours. After sunrise, the northerly components strengthen in speed and frequency. A noticeable shift in winds is observed in the afternoons, with a substantial decrease in winds from the east and increase in winds from the northwest.

Speeds remain fast in the afternoons, similar to those experienced during the daytime morning hours. Winds during the night-time hours (18:00 – 24:00) show a return to the usual trend, with easterly winds dominating, although an increase in southerly and westerly winds is also observed. Wind speeds slow during this period, seldom exceeding 8 m/s, with fastest winds originating from the east.

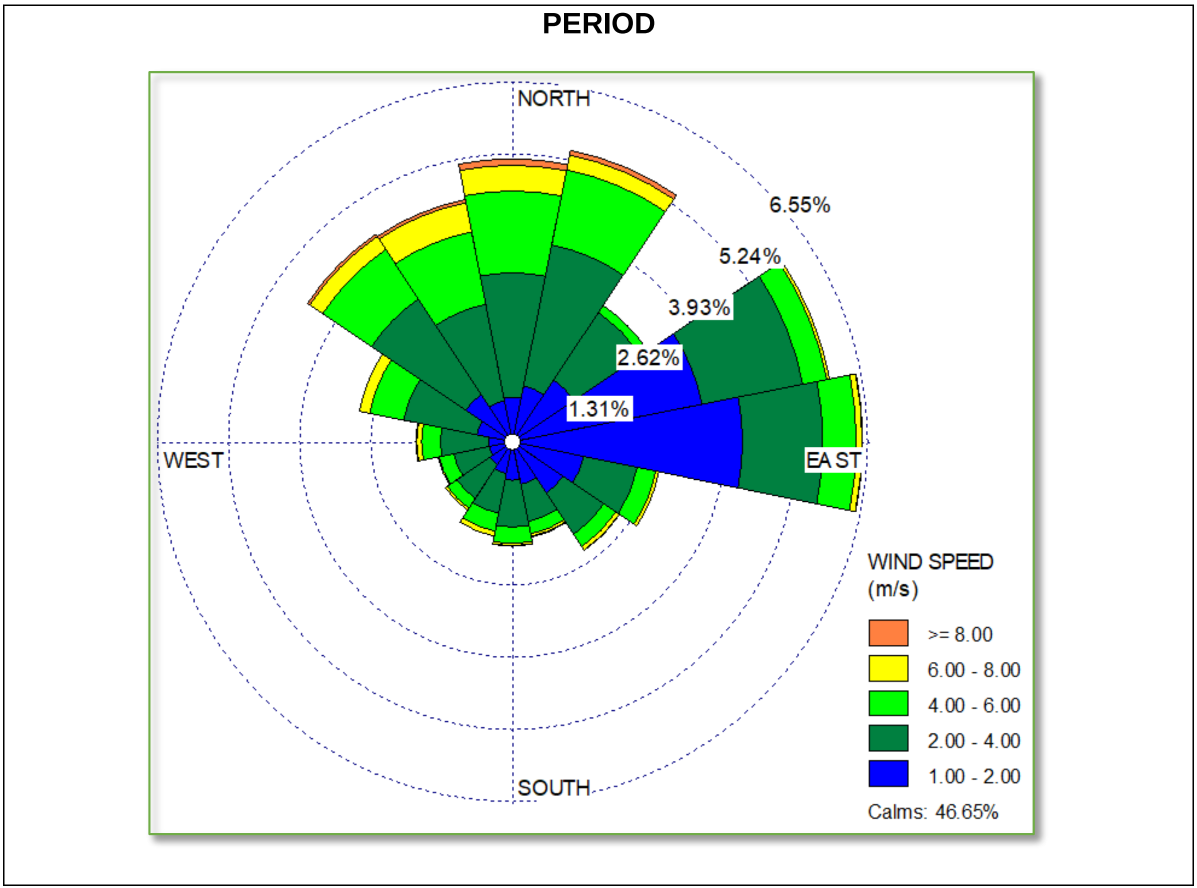


**Figure 15: Period wind rose – Agricultural Research Council Meteorological Station near Ottosdal - data 01 January 2017 – 31 December 2019) (adapted from the WSP Environmental Report: 41102258 EnviroGistics Wonderstone Mine Desktop AQ_2020 10 27.pdf).**

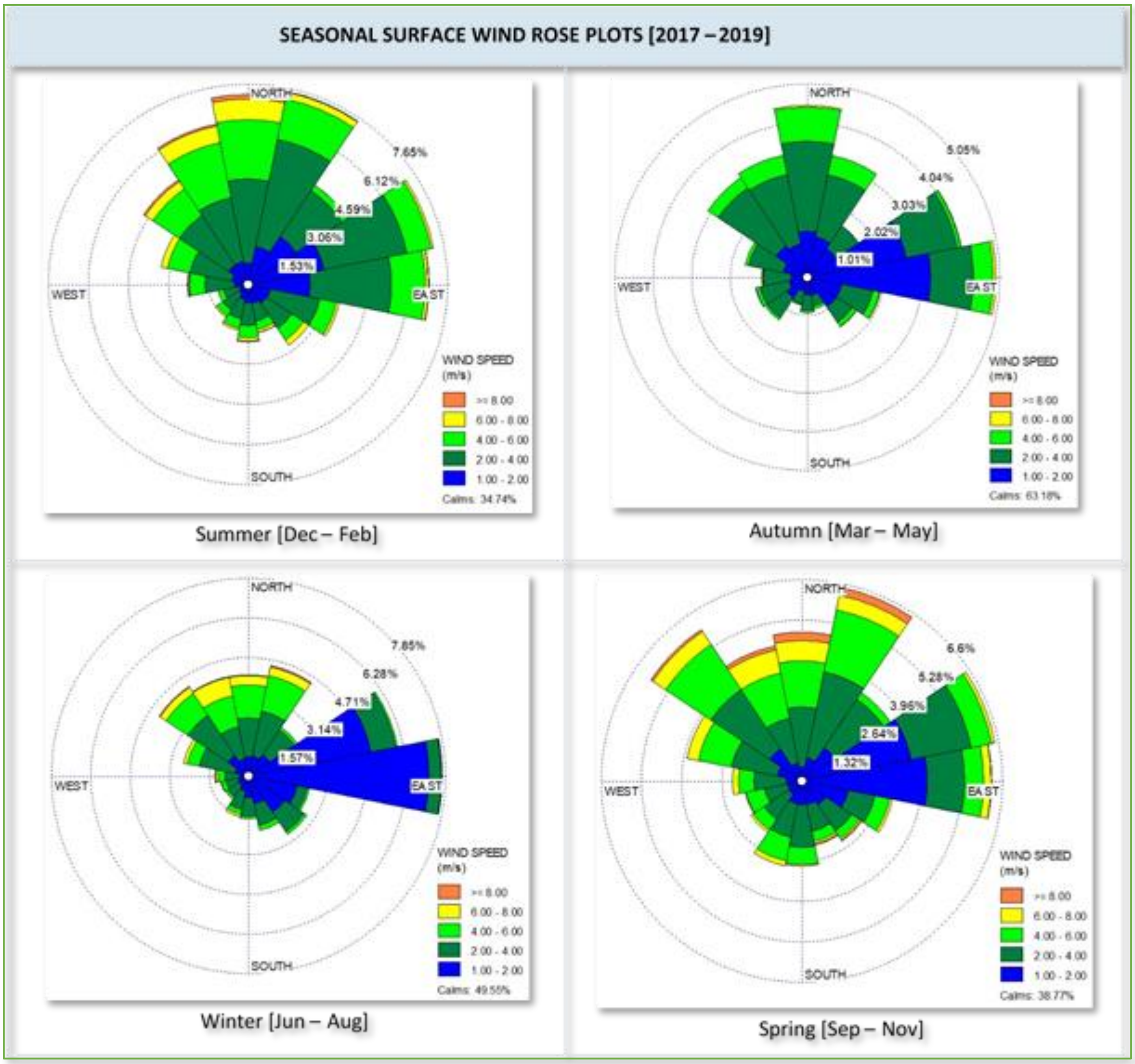


**Figure 16: Seasonal variation of winds in summer season (December - February) (top right), autumn season (March – May) (bottom left), winter season (June – August) and spring season (September – November) (top left) (bottom right) (Agricultural Research Council near Ottosdal - data 01 January 2017 – 31 December 2019)). (Adapted from the WSP Environmental Report: 41102258 EnviroGistics Wonderstone Mine Desktop AQ_2020 10 27.pdf).**

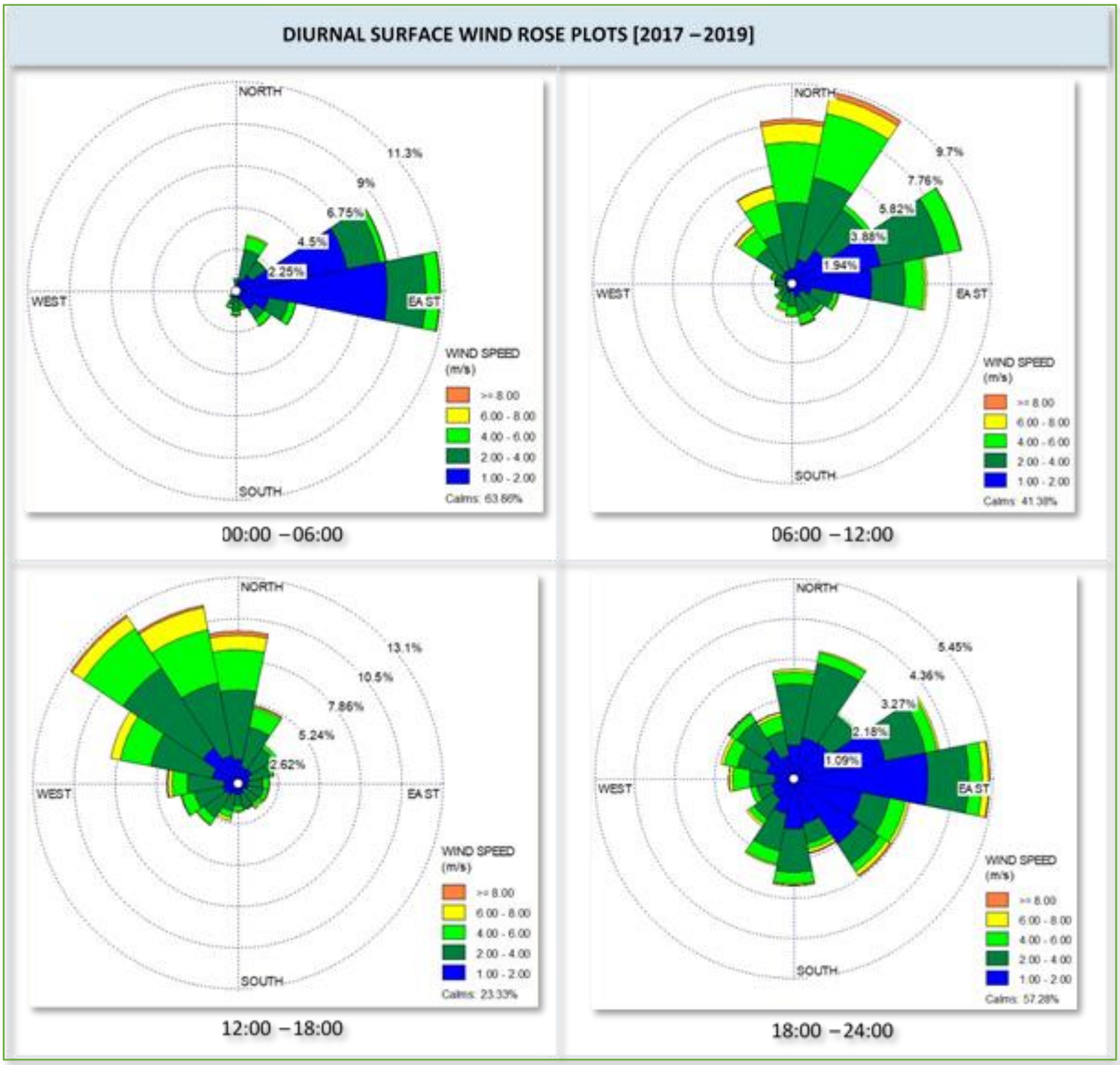


**Figure 17: Diurnal variation of winds between Night time 00:00 – 06:00 (top left), Morning 06:00 – 12:00 (top right), Afternoon 12:00 – 18:00 (bottom left) and Evening 18:00 – 24:00 (bottom right). Agricultural Research Council Meteorological Station near Ottosdal - data 01 January 2017 – 31 December 2019) (adapted from WSP Environmental Report: 41102258 EnviroGistics Wonderstone Mine Desktop AQ_2020 10 27.pdf).**

In terms of Köppen Climate Classification, the area belongs to BSk climate group (Cold semi-arid climates).

Cold semi-arid climates (type "BSk") tend to be located in elevated portions of temperate zones, typically bordering a humid continental climate or a Mediterranean climate. They are typically found in continental interiors some distance from large bodies of water. Cold semi-arid climates usually feature warm to hot dry summers, though their summers are typically not quite as hot as those of hot semi-arid climates.

Meteoblue has been archiving weather model data since 2007 and in 2014 started to calculate weather models with historical data from 1985 onwards and generated a continuous 30-year global history with hourly weather data. The climate diagrams are the first simulated climate data-set made public on the Internet. The Meteoblue weather history covers any place on Earth. They give good indications of typical climate patterns and expected conditions (temperature, precipitation, sunshine and wind). The simulated weather data have a spatial resolution of approximately 30 km.

Meteoblue climate diagram was extracted for a point near the existing Wonderstone mine site (26.81°S 26.01°E) and is presented in Figure 18.

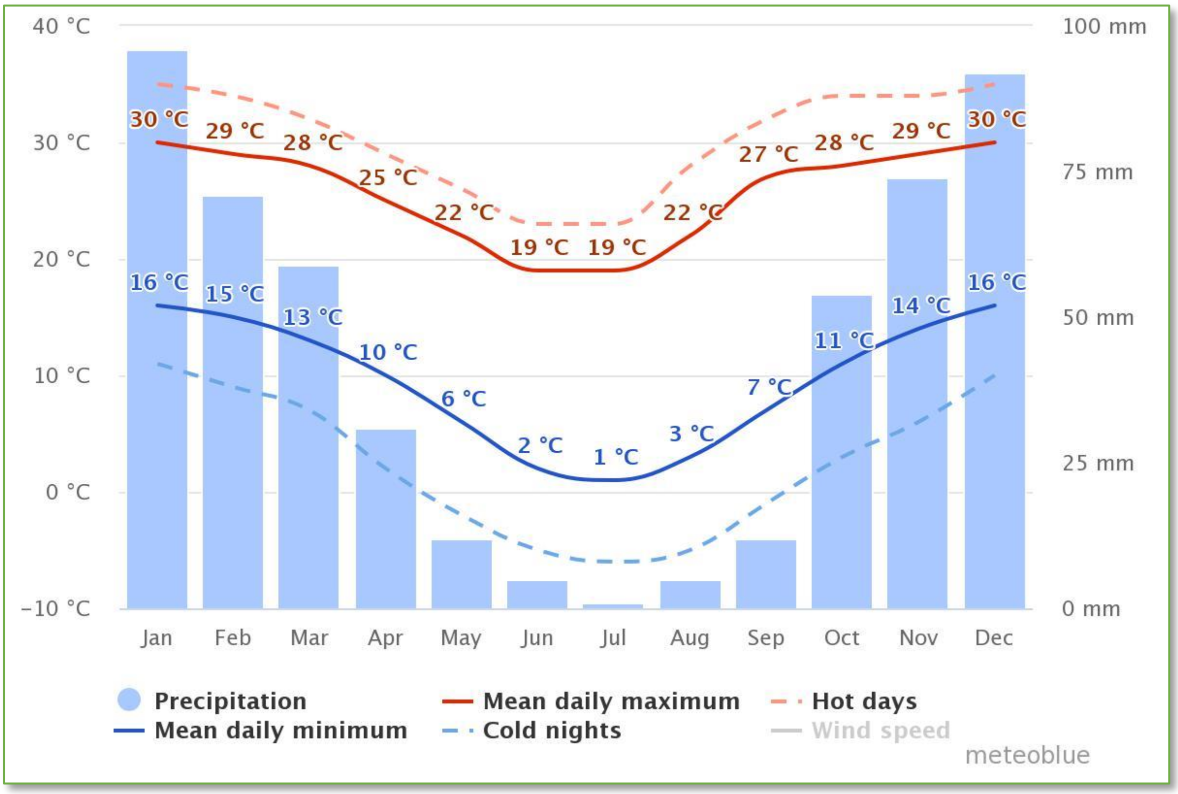


**Figure 18: Average temperature, precipitation data for Ottosdal (26.81°S 26.01°E) (www.meteoblue.com) [Date accessed: 22 February 2022].**

### 3.3.5 Evaporation

The rate of evaporation will depend upon a number of factors. Evaporation rates increase when temperatures are higher. An increase of 10°C will approximately double the rate of evaporation. The humidity of the surrounding air will also influence evaporation. Drier air has a greater "thirst" for water vapour than humid, moist air. It follows therefore, that the presence of wind will also increase evaporation. On still days, water evaporating into the air remains close to its source, increasing the local humidity. As the moisture content of the air increases, evaporation will diminish. If, however, a steady flow of air exists to remove the newly formed vapour, the air surrounding the water source will remain dry, "thirsty" for future water.

As shown in Figure 19 and Table 12, the annual maximum, minimum and mean monthly evaporation rates for the historical Ottosdal S-Pan Station (Station Code: 0435019 5, coordinates 26°49'1.65"S, 26° 0'51.59"E) (approximately 9 km south of the project area) for the period 1961 - 1987 are 268 mm, 117 mm and 179 mm, respectively. The highest monthly maximum evaporation (429 mm) occurred in October. The rate decreased to the monthly minimum of 64 mm in May.

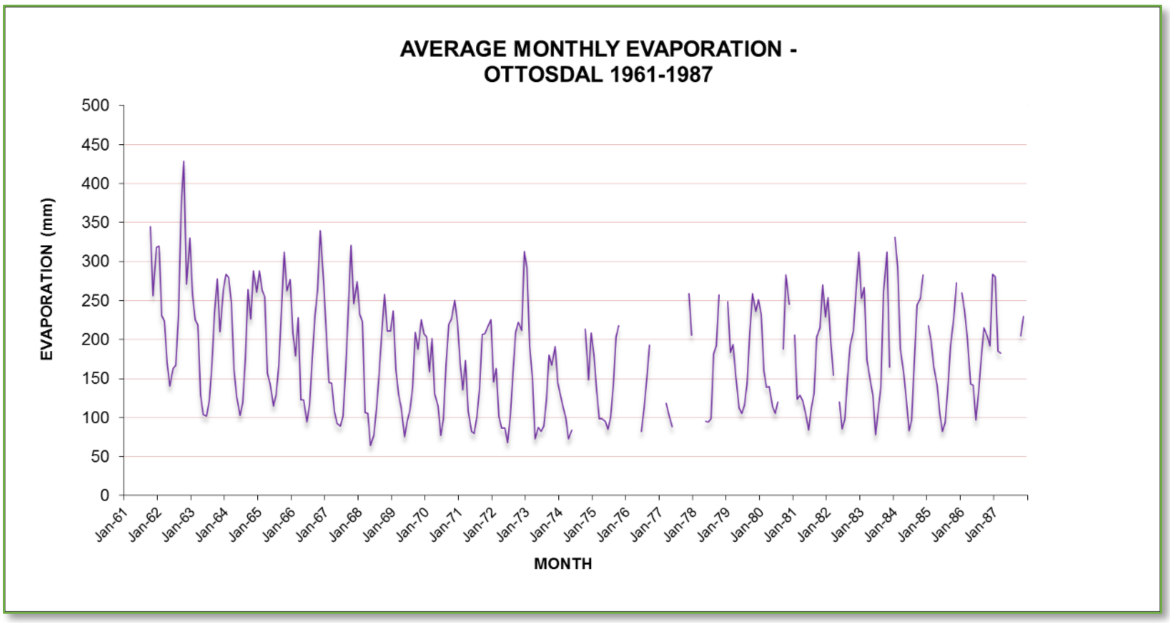


**Figure 19: Average monthly evaporation for Ottosdal S-Pan Evaporation Station (1961 – 1987) (Source: South African Weather Service).**

**Table 12: Maximum, minimum and mean monthly evaporation rates for the Ottosdal (Symon's Pan) S-Pan evaporation station for 1961-1987 period (South African Weather Service).**

| Evaporation (mm) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Ann |
| Monthly Max. | 331 | 293 | 255 | 170 | 143 | 163 | 168 | 232 | 369 | 429 | 339 | 330 | 268 |
| Monthly Min. | 129 | 114 | 98 | 73 | 64 | 68 | 90 | 123 | 180 | 167 | 149 | 145 | 117 |
| Monthly Mean | 236 | 191 | 168 | 125 | 107 | 93 | 111 | 157 | 222 | 252 | 239 | 253 | 179 |

### 3.3.6 Boundary Layer Properties and Atmospheric Stability

The region of the atmosphere governing transport and dispersion of the majority of the pollutants is the planetary boundary layer. This layer is defined as the layer where the wind structure is influenced by the surface of the Earth.

The height of the planetary boundary layer varies with the atmospheric stability and this is important for the concentrations of pollutants in the air because the majority of the pollutant mass typically is confined within this layer. During night-time when conditions in most cases are stable, the planetary boundary layer is shallow, down to 20-50 metres and the surface concentration of pollutants can therefore be quite high, especially close to emission sources that are active during the night. Under unstable conditions, the planetary boundary layer can be as high as 2 kilometres and pollutants are in this case distributed in the air column mainly by convective turbulence. In the vicinity of the top of the boundary layer, the horizontal winds are typically stronger and the pollutants that end up at these higher levels may be transported far away from the emission sources. In neutral conditions, emitted pollutants are quickly mixed in the air by mechanical turbulence and the surface concentration is not particularly high. During neutral conditions strong horizontal wind speeds can transport pollutants across large distances.

The atmospheric conditions may be divided into three broad classes in terms of stability: neutral, stable and unstable conditions. These major three categories are characterised by the following:

- Neutral conditions where the temperature is homogeneous throughout the boundary layer. This situation typically occurs in the transition from day to night and is characterised by strong winds and clouds and large amounts of mechanical turbulence.
- Stable conditions where the temperature is lowest close to the surface and increases towards the top of the boundary layer. This situation typically occurs

during nighttime or in winter situations and is characterised by little turbulence and a strong stratification of the planetary boundary layer which is quite shallow. This class can be further divided into stable and very stable classes.

- Unstable conditions where the temperature of the air closest to the surface is higher than the temperature of the air above it. This situation typically occurs during the daytime in summer when the sun is shining, and it is characterised by large amounts of convective turbulence usually resulting in the formation of cumulus clouds during the day. This class can be further divided into very unstable, moderately unstable and unstable classes.

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 mainly on the extent of solar radiation, growing gradually from sunrise to reach a maximum at about 5-6 hours after sunrise. The 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.

For elevated releases, the highest ground-level concentrations would occur during unstable, day-time conditions. The wind speed resulting in the highest ground level concentration depends on the 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 speed, on the other hand, the plume may reach the ground closer, but due to the increased ventilation, it will be more diluted. A wind speed between these extremes would therefore be responsible for the highest ground-level concentrations. The highest concentrations for low-level releases would occur during weak wind speeds and stable atmospheric conditions. Air pollution episodes frequently occur just prior to the passage of a frontal system that is characterised by calm wind and stable conditions.

The refined classes of atmospheric stability classes are further defined in Table 13 and Table 14.

Table 13: Atmospheric Stability Classes.

| 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 | Very stable | Low winds, clear skies, cold night-time conditions |

Table 14: Meteorological conditions that define the Pasquill stability classes.

| Surface wind speed | Daytime incoming solar radiation | | | Night time cloud cover | |
|---|---|---|---|---|---|
| m/s | Strong | Moderate | Slight | > 50% | < 50% |
| < 2 | A | A – B | B | E | F |
| 2 – 3 | A – B | B | C | E | F |
| 3 – 5 | B | B – C | C | D | E |
| 5 – 6 | C | C – D | D | D | D |
| > 6 | C | D | D | D | D |

*Note: Class D applies to heavily overcast skies, at any wind speed day or night.

## 3.4 Site Visit

A site visit was conducted by VJ Air for this air quality impact assessment. Sufficient project information was received from the client, and the reliance was put on the Wonderstone Resource Report for FY 2020/2021 compiled by C. van der Merwe (Competent Person) and the previous studies and monitoring reports conducted in the area.

## 3.5 Ambient Air Quality and Sources of Air Pollution within the Region

### 3.5.1 Existing Sources of Emissions near the Project Site

Regional Road R505 and network of gravel and unpaved roads, active mining site (opencast), small town and low-income rural settlement that uses wood, coal and paraffin for heating and cooking purposes are located in the vicinity of the existing and proposed site. These land-use activities contribute to baseline pollutant concentrations via windblown dust from mine stockpiles and dumps, vehicle tailpipe emissions and dust from vehicle entrainment, together with household fuel combustion, biomass burning, veld fires and various fugitive dust sources.

***Sources of atmospheric emissions include:***

- Gaseous and particulate emissions from vehicles (tailpipe emissions);
- Miscellaneous fugitive dust sources including vehicle entrainment on roads and windblown dust from open areas;
- Gaseous and particulate emissions from biomass burning/veld fires (e.g. wild-fires).
- Gaseous and particulate emissions from adjacent mining operation; and
- Gaseous and particulate emissions from household fuel burning.

**Vehicle Entrainment of Dust from Paved and Unpaved Roads and Tailpipe Emissions**

The force of wheels of vehicles travelling on unpaved roadways causes the pulverisation of the surface material. Particles are lifted and dropped from the rotating wheels and the road surface is exposed to strong air currents in turbulent shear with the surface. The turbulent wake behind the vehicle continues to act on the road surface after the vehicle has passed. The quantity of dust emissions from unpaved roads varies linearly with the volume of traffic, as well as the speed of the vehicles. The site that is proposed for mine development is in the vicinity of the corridor of R505 (Lichtenburg – Wolmaransstad) and a network of unpaved, gravel local roads.

**Household Fuel Combustion (Domestic Fuel Burning)**

Despite the intensive national electrification programme, a large number of households continue to burn fuel to meet all or a portion of their energy requirements. The main fuels with air pollution potentials used by households within the study region are coal, wood and paraffin. The distribution patterns of fuel use are linked with the former townships and informal residential areas. Pollutants released from these fuels include CO, $NO_2$, $SO_2$, inhalable particulates and polycyclic aromatic hydrocarbons. Particulates are the dominant pollutant emitted from the burning of wood. Smoke from wood burning contains respirable particles that are small enough in diameter to enter and deposit in the lungs. These particles comprise a mixture of inorganic and organic substances including aromatic hydrocarbon compounds, trace metals, nitrates and sulphates. Polycyclic aromatic hydrocarbons are produced as a result of incomplete combustion and are potentially carcinogenic in wood smoke (Maroni et al., 1995). The main pollutants emitted from the combustion of paraffin are $NO_2$, particulates, carbon monoxide and polycyclic aromatic hydrocarbons.

Domestic fuel burning shows a characteristic diurnal and seasonal signature. Periods of elevated domestic fuel burning, and hence emissions, occurs in the early morning and evening for space heating and cooking purposes. During the winter months, an increase in domestic fuel burning is recorded as the demand for space heating and cooking increases with the declining temperature. The site is located close to the low-income area of Letsopa, located south from the Wonderstone Ltd mine site (~6.8 km).

**Biomass Burning (Veld Fires)**

A veld fire is a large-scale natural combustion process that consumes various ages, sizes, and types of plants growing outdoors in a geographical area. Consequently, veld fires are potential sources of large amounts of air pollutants that should be considered when attempting to relate emissions to air quality. The size and intensity, even the occurrence, of a veld fire depend directly on such variables as meteorological conditions, the species of vegetation involved and their moisture content, and the weight of consumable fuel per hectare (available fuel loading). Veld fires are not easily quantified due to the irregular and seasonal nature of this source, but are also considered to be an important contributor to ambient particulate concentrations, particularly during the fire-burning season.

**Mining**

The closest mining activity to the Wonderstone Ltd project area is located on the farm Witpoort 281 IP, and this is a pyrophyllite mine belonging to Idwala Industrial Holdings. It is an open pit crude pyrophyllite operation that supplies Idwala Industrial Minerals in Benoni, Gauteng Province, that mills and micronizes the crude pyrophyllite.

## 3.5.2 Measured Ambient Air Quality

### Particulate Matter ($PM_{10}$ and $PM_{2.5}$)

The identification of existing sources of emission and the characterisation of ambient pollutant concentrations is fundamental to the assessment of the potential for cumulative impacts in the region.

The North West Province currently operates Lichtenburg Ambient Air Quality Monitoring station on the premises of Boikhutso Clinic in low income settlement of Boikhutso, on the southwest outskirts of Lichtenburg town, some 62 km north-northeast of the existing Wonderstone Ltd operations (Figure 22). It was commissioned in 2009, in the low-income community with a strong reliance on domestic combustion. The station is equipped to monitor meteorological parameters, $SO_2$, $NO_x$, CO, $O_3$, $PM_{2.5}$ and $PM_{10}$. Long term availability of air quality data from this station is limited, and the most recent (2015-2016) $PM_{10}$ and $PM_{2.5}$ daily monitoring data is presented in Figure 20.

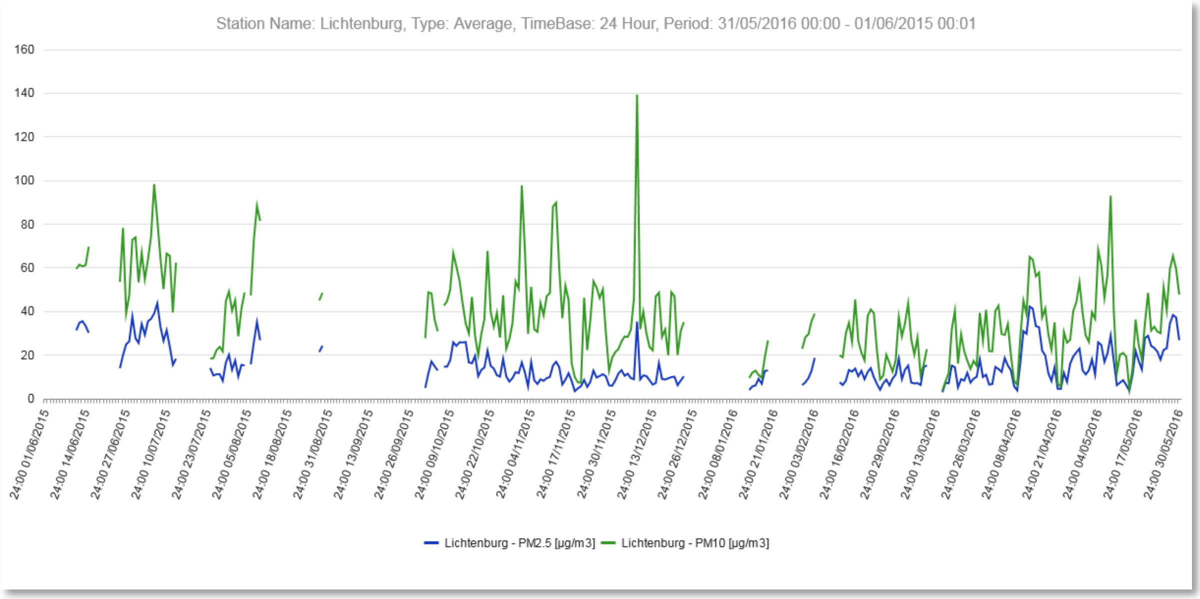


**Figure 20: Daily $PM_{10}$ and $PM_{2.5}$ concentrations at Lichtenburg Air Quality Monitoring Station for the period 01 June 2015 to 31 May 2016 (https://saaqis.environment.gov.za/)).**

## 3.5.3 Dust Fallout

To assess the existing ambient air quality in the area, data was obtained from the Wonderstone Mine. Wonderstone historically undertook dust fallout monitoring on the fenceline of the mining boundary. Monthly dust fallout monitoring was undertaken from March 2013 – September 2013, where after monitoring frequency was reduced to quarterly, with monitoring ending in June 2015. No further dust fallout monitoring has been done since June 2015.

Wonderstone Mine had a dust fallout network consisting of eight single dust buckets (Table 15 and Figure 22) during 2013-2015 period. The measured dust fallout for the period February 2013 to June 2015 is provided in Table 16 and Figure 21. Dust fallout measured during this period was all below the NDCR for residential areas (600 mg/m²/day). Thus, all sites are within the NDCR for residential areas for the period February 2013 to June 2015.

Given the age of this dataset, the data presented below must be viewed with caution, and may not necessarily represent the current air quality situation of the area. Further, the dust fallout levels measured during this period were unrealistically low for a mining area and relatively dry environment. Multidirectional dustfall units are not in compliance with the National Dust Control Regulations, and can only be used internally as indication of dust load at the monitoring point.

National Occupational Health & Safety Consultants have been appointed by Wonderstone Ltd to establish and maintain a dustfall monitoring programme during 2013 (before the publication of GNR 827 – National Dust Control Regulations, in terms of section 53(o), read with Section 32 of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004).

**Table 15: Historical dustfall sites coordinates and classifications at Wonderstone Mine.**

| Site ID | Classification | Latitude (S) | Longitude (E) | Sampler type |
|---|---|---|---|---|
| NW Perimeter | Non-residential | 26.73032 | 25.99190 | Single bucket ASTM D1739 Compliant |
| N Perimeter | Non-residential | 26.72834 | 25.99365 | Single bucket ASTM D1739 Compliant |
| NE Perimeter | Non-residential | 26.72871 | 25.99667 | Single bucket ASTM D1739 Compliant |
| E Perimeter | Non-residential | 26.73111 | 25.99888 | Single bucket ASTM D1739 Compliant |
| SE Perimeter | Non-residential | 26.73650 | 26.00005 | Single bucket ASTM D1739 Compliant |
| S Perimeter | Non-residential | 26.73911 | 25.99800 | Single bucket ASTM D1739 Compliant |
| SW Perimeter | Non-residential | 26.73839 | 25.99287 | Single bucket ASTM D1739 Compliant |
| W Perimeter | Non-residential | 26.73429 | 25.99221 | Single bucket ASTM D1739 Compliant |

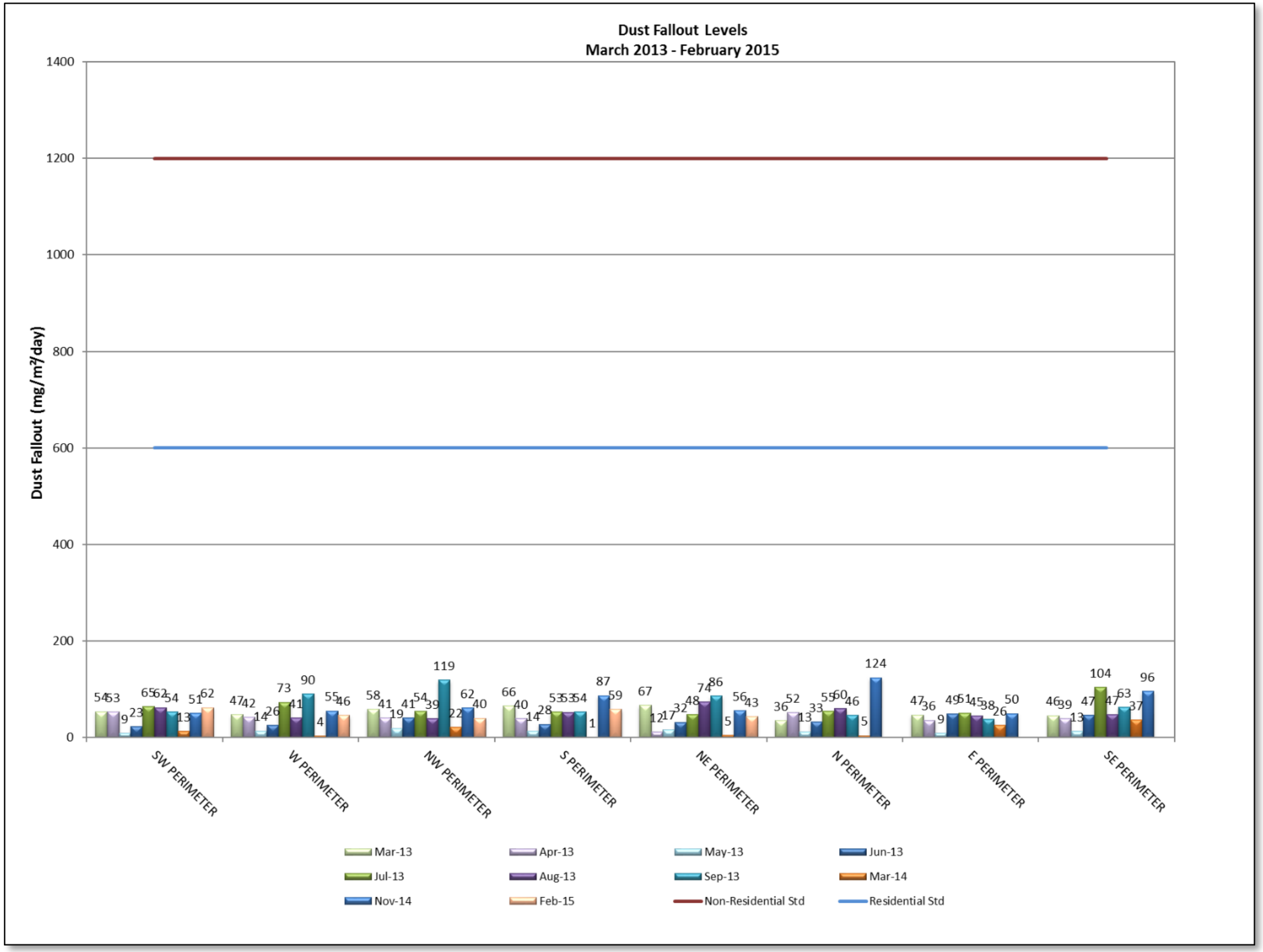


**Figure 21: Dust fallout measured at Wonderstone Ltd Mine for the period March 2013 to February 2015.**

**Table 16: Dustfall results and compliance for 2013 calendar year at Wonderstone Mine for March 2013 - February 2015 (NDCR: green= above residential standard, red = above non-residential standard).**

| Site Code | NDCR Classification | Dustfall (mg/m²/day) | | | | | | | | | | Compliance (2013-2015) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mar-13 | Apr-13 | May-13 | Jun-13 | Jul-13 | Aug-13 | Sep-13 | Mar-14 | Nov-14 | Feb-15 | |
| SWP | Non-residential | **54** | **53** | **9** | **23** | **65** | **62** | **54** | **13** | **51** | **62** | Yes |
| WP | Non-residential | **47** | **42** | **14** | **26** | **73** | **41** | **90** | **4** | **55** | **46** | Yes |
| NWP | Non-residential | **58** | **41** | **19** | **41** | **54** | **39** | **119** | **22** | **62** | **40** | Yes |
| SP | Non-residential | **66** | **40** | **14** | **28** | **53** | **53** | **54** | **1** | **87** | **59** | Yes |
| NEP | Non-residential | **67** | **12** | **17** | **32** | **48** | **74** | **86** | **5** | **56** | **43** | Yes |
| NP | Non-residential | **36** | **52** | **13** | **33** | **55** | **60** | **46** | **5** | **124** | **37** | Yes |
| EP | Non-residential | **47** | **36** | **9** | **49** | **51** | **45** | **38** | **26** | **50** | **46** | Yes |
| SEP | Non-residential | **46** | **39** | **13** | **47** | **104** | **47** | **63** | **37** | **96** | **77** | Yes |

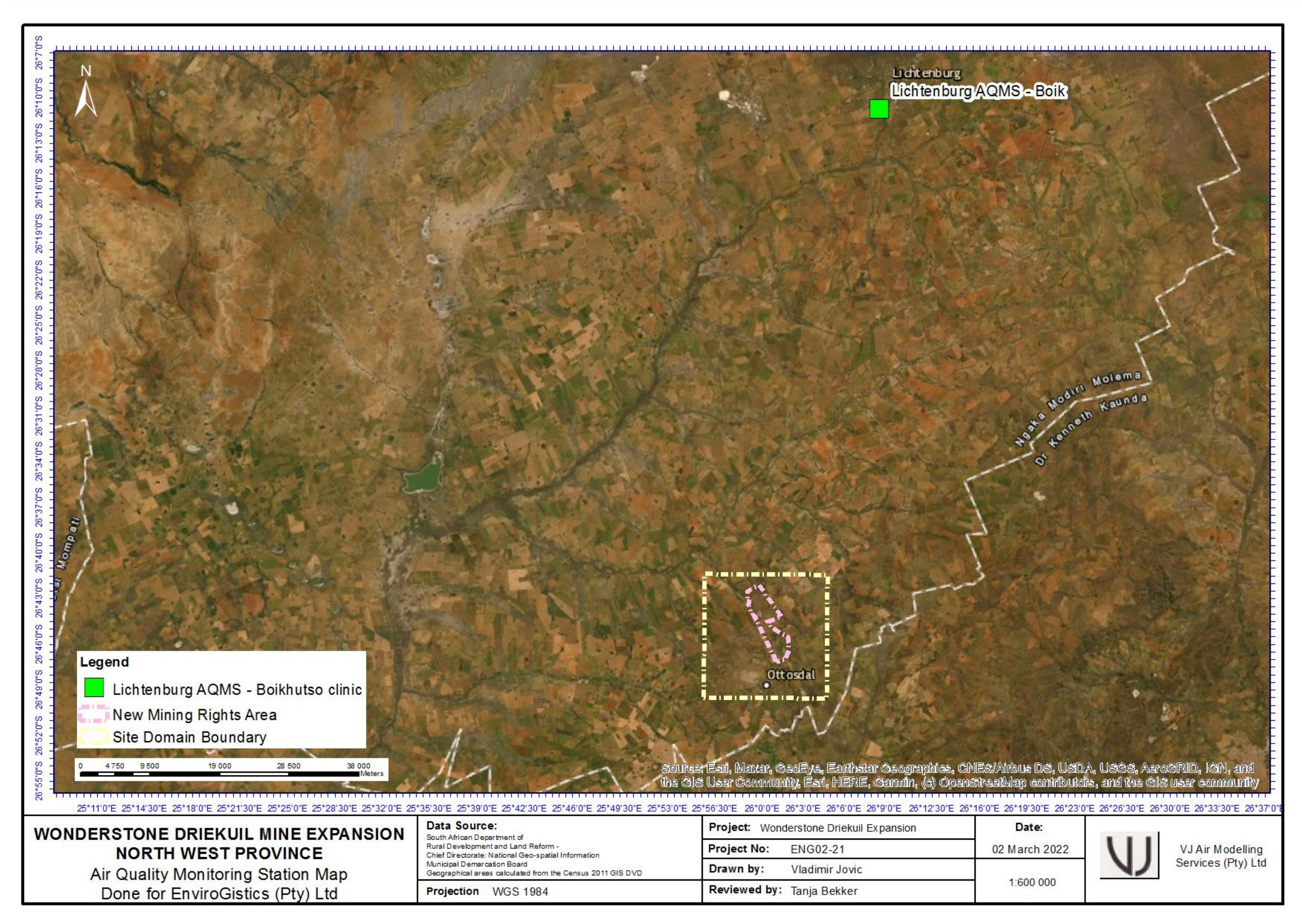


**Figure 22: The closest Air Quality Monitoring Station (AQMS) in the vicinity of the Wonderstone Ltd Project area.**

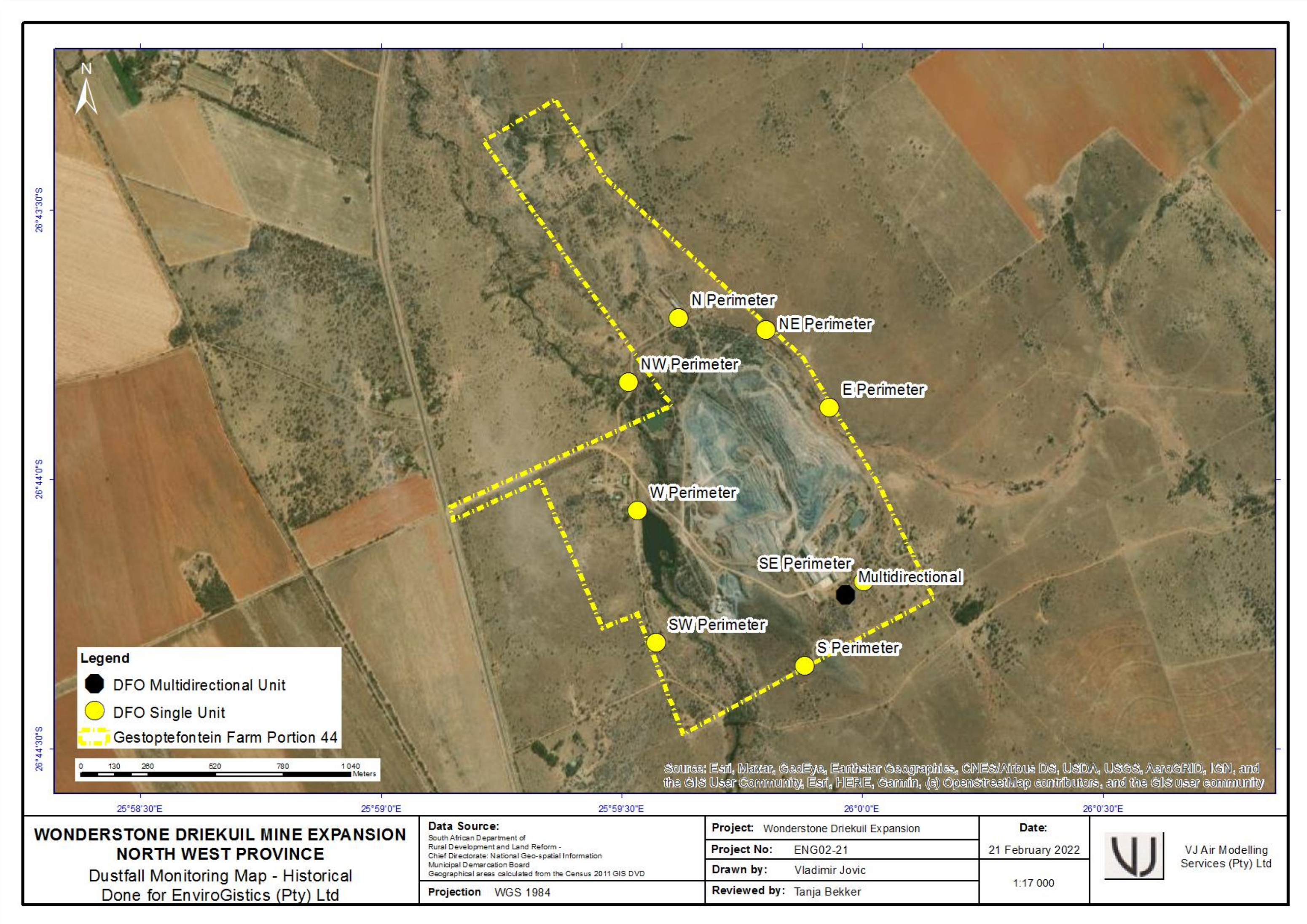


**Figure 23: Historical dust fallout monitoring sites at Wonderstone Mine.**

## 3.6 Human Health Effects

### 3.6.1 Particulates

Airborne particles in the air that can be aspirated into the nose or mouth during normal breathing are known as "inhalable particles." The nasal openings permit very large dust particles to enter the nasal region, along with much finer airborne particulates. Larger particles are deposited in the nasal region by impaction on the hairs of the nose or at the bends of the nasal passages. Smaller particles pass through the nasal region and are deposited in the tracheobronchial and pulmonary regions. Inhalability decreases gradually with increasing particle diameter, reaching a level of about 50 percent at 100 microns (µm).

"Subfractions" of the inhalable fraction are the particles that can penetrate through the upper respiratory tract and enter the thoracic airways (lower respiratory tract). The aerodynamic particle diameter for 50 % penetration into the thorax is 10 microns. Particles are removed by impacting the wall of the bronchi when they are unable to follow the gaseous streamline flow through subsequent bifurcations of the bronchial tree. As the airflow decreases near the terminal bronchi, the smallest particles are removed by Brownian motion, which pushes them to the alveolar membrane (CEPA/FPAC Working Group, 1998; Dockery et al, 1993).

Most of the airborne inhalable particles are a result of mechanical disruption such as crushing, grinding, evaporation of sprays, or suspensions of dust from construction, wind erosion of exposed stockpiles, tailings dams and agricultural operations.

Particles of concern with health impact potential can be classified by their aerodynamic properties into coarse particles, $PM_{10}$ (particulate matter with an aerodynamic diameter of less than 10 µm) and fine particles, $PM_{2.5}$ (particulate matter with an aerodynamic diameter of less than 2.5 µm) (Harrison and van Grieken, 1998). The fine particles contain the secondarily formed aerosols such as sulphates and nitrates, combustion particles and recondensed organic and metal vapours. The coarse particles contain earth crust materials and fugitive dust from roads and industries (Fenger, 2002).

Air quality guidelines and standards for particulates are given for various particle size fractions, including total suspended particulates (TSP), inhalable particulates or $PM_{10}$ (i.e. particulates with an aerodynamic diameter of less than 10 µm), and respirable particulates of $PM_{2.5}$ (i.e. particulates with an aerodynamic diameter of less than 2.5 µm). Although TSP is defined as all particulates with an aerodynamic diameter of less than 100 µm, and an effective upper limit of 30 µm, aerodynamic diameter is frequently assigned.

TSP (identified as dust fallout) are particles with an aerodynamic diameter greater than 30 µm that have been entrained into the air by a physical process such as wind, movement of vehicles, stack emissions and fugitive dust. These particles are generally too heavy to remain in suspension in the air for any period of time and fall out of the air over a relatively short distance depending on a combination of various factors such as particle size, density, temperature (of the air and particle), emission velocity or method, ambient wind speed and humidity. These particles are therefore commonly known as "dust fallout". Particulates in this range are generally classified as nuisance dust and can cause physical damage to property and physical irritation to plants, animals and humans.

$PM_{10}$ and $PM_{2.5}$ are of concern due to their health impact potentials. As indicated previously, such fine particles are able to be deposited and damage the lower airways and gas-exchanging portions of the lung.

In terms of health impacts, particulate air pollution is associated with effects on the respiratory system (WHO, 2000). Particle size is important for health because it controls where in the respiratory system given particle deposits. Fine particles are thought to be more damaging to human health than coarse particles as larger particles are less respirable in that they do not penetrate deep into the lungs compared to smaller particles (Manahan, 1991). Larger particles are deposited into the extra-thoracic part of the respiratory tract while smaller particles are deposited into the smaller airways leading to the respiratory bronchioles (WHO, 2000).

Recent studies suggest that short-term exposure to particulate matter leads to adverse health effects, even at low concentrations of exposure (below 100 µg/m$^3$). Morbidity effects associated with short-term exposure to particulates include increases in lower respiratory symptoms, medication use and small reductions in lung function. Long-term exposure to low concentrations (~10 µg/m$^3$) of particulates is associated with mortality and other chronic effects such as increased rates of bronchitis and reduced lung function

(WHO, 2000). Those most at risk include the elderly, individuals with pre-existing heart or lung disease, asthmatics and children.

### 3.6.2 Particulates - Long-term exposure

Long-term exposure to low concentrations (~10 µg/m$^3$) of particulates is associated with mortality and other chronic effects such as increased rates of bronchitis and reduced lung function (WHO, 2000). The short term and long-term effects associated with particulate matter are depicted in Table 17.

Studies have indicated an association between lung function and chronic respiratory disease and airborne particles. Older studies by Chestnut et al (1991) found that Forced Vital Capacity (FVC) decreases with increasing annual average particulate levels with an apparent threshold at 60 µg/m$^3$. Using chronic respiratory disease data, Schwartz (1993) determined that the risk of chronic bronchitis increased with increasing particulate concentrations, with no apparent threshold.

Few studies have been undertaken to document the morbidity effects of long-term exposure to particulates. Recently, the Harvard Six Cities Study showed increased respiratory illness rates among children exposed to increasing particulate, sulphate and hydrogen ion concentrations. Relative risk estimates suggest an 11% increase in cough and bronchitis rates for each 10 µg/m$^3$ increase in annual average particulate concentrations.

**Table 17: Short-term and long-term health effects associated with exposure to PM (after WHO, 2000).**

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

# 4. PLAN OF STUDY FOR THE EIA

The main purpose for conducting the AQIA is to identify key activities that might have significant air quality impacts during the project planning, construction and operational phases. In order to sufficiently understand the possible impact of the proposed expansion project the following activities will be undertaken:

## 4.1 Baseline Air Quality Assessment

The baseline assessment will consist of:

- A site visit to determine the footprint and layout of the existing Wonderstone mining operation and proposed expansion, as well as any significant surrounding sources of emissions;
- A description of the receiving environment, focusing on sensitive receptors;
- Assessment of the existing air quality situation in the area with the use of ambient monitoring data (historical);

Information gathering, inclusive of, but not limited to:

- Baseline climatic and air quality characterisation.
- Existing sources of emissions.
- Existing air quality monitoring data.
- A detailed list of sensitive receptors in the vicinity of the existing and proposed Wonderstone mining operation.

## 4.2 Development of Emissions Inventory

A detailed, accurate source emissions inventory is extremely important to produce an accurate dispersion model. The inventory will be developed through the calculation of emissions by mass, source, time period and pollutant. These variables are calculated by using individual emission source information with their associated emission factors, and the respective operational parameters over a determined period of time. These parameters are then used to calculate the total source related emissions at the Wonderstone Mine, including:

- Calculation of emissions from the existing activities and proposed expansion project; and
- Verification of the existing emissions inventory and capturing into an electronic format.

## 4.3 Dispersion Modelling

Source inventory data will be used as input for the creation of a dispersion model that demonstrates the impact of emissions associated with the existing activities and proposed expansion project to the existing situation. AERMOD modeling suite will be used to model the proposed Wonderstone expansion project. AERMOD is new generation air dispersion model designed for short-range dispersion of airborne pollutants in steady state plumes.

AERMOD system:

- Uses hourly sequential meteorological files with pre-processor to generate flow and stability regimes for each hour.
- Produce output maps of plume spread with key isopleths for visual interpretation.

Statistical output of the model allows for direct comparisons with the latest national ambient air quality standards (NAAQS) for compliance testing.

The model will be setup to compute ambient ground level concentrations (GLC) based on both long-term (annual / chronic) and short-term (worst-case / acute) averaging periods. Model scenarios will be for cumulative impacts (no background concentrations are available to be included), such that statistical output will be compared with applicable ambient air quality standards for compliance assessment purposes. Additionally, model predictions will be compared to actual monitored data (historical).

## 4.4 Air Quality Impact Assessment

An AQIA will be required as part of the EIA process to demonstrate the impacts of the proposed operations on the existing air quality situation of the area. The report will include all methodological and technical information required to support the findings, as well as focusing on the potential impacts on the sensitive receptors.

## 4.5 Development of an Air Quality Management Plan

The AQIA report will also include an air quality management plan (AQMP) that details an emissions management and monitoring plan for key pollutants. Focus will be afforded to the following air pollutants:

- Particulate matter smaller than 10 microns ($PM_{10}$) and 2.5 microns ($PM_{2.5}$); and
- TSP (as deposited dust).

Mitigation recommendations will also be provided for those sources identified as key emitters, where emission reduction strategies should be implemented.

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# Appendix A – Specialist Qualifications

**Table A1: Specialist consulted for this air quality assessment and his qualifications**

| ASPECT INVESTIGATED | SPECIALIST | QUALIFICATION | DATE OF FIELD SURVEY | REPORT DATE |
|---|---|---|---|---|
| Air Quality | V Jovic (*Pr.Sci.Nat.*) (400054/17) (Principal assessor) | B.A. Hons. Town and Regional Planning (University of Belgrade, Republic of Serbia)<br>AERMOD Air Dispersion Modelling Course<br>October 2014, NACA<br>CALPUFF Advanced techniques in Dispersion Modelling Course<br>October 2014, NACA<br>Air Dispersion Modelling Short Course<br>March 2014, NACA<br>CALPUFF Advanced techniques in Dispersion Modelling Course<br>October 2010, UJ<br>AERMOD Air Dispersion Modelling Course<br>March 2010, UJ<br>Introduction to Atmospheric Dispersion Modelling<br>February 2010, NACA<br>CALPUFF Modelling Course<br>October 2008, NACA & UJ | 01 February 2022 | 14 March 2022 |

# Appendix B – Declaration of Independence

I, **<u>Vladimir Jovic</u>**, declare, as a specialist appointed in terms of the National Environmental Management Act (Act No 108 of 1998) and the associated 2017 Environmental Impact Assessment (EIA) Regulations, that I:

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Air Quality Specialist

VJ Air Modelling Services (Pty) Ltd

14 March 2022

Signature of the Specialist…………………………………..