AIR QUALITY IMPACT ASSESSMENT FOR THE KALABASFONTEIN PROJECT

ENVIRONMENTAL IMPACT MANAGEMENT SERVICES (PTY) LTD

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EXECUTIVE SUMMARY

Forzando Coal Mines (Pty) Ltd. operates mining operations at both the Forzando North Shaft and Forzando South Shaft in Mpumalanga. Through an intensive drilling exercise on these areas, economically viable blocks of coal have been defined with the intention to access these newly defined blocks of coal from the existing Forzando South incline. As such, a proposed extension of the current mining area is planned, known as the Kalabasfontein project. The Kalabasfontein project will require minimal new surface infrastructure as the mining method to be employed is underground mining and existing surface infrastructure from the Forzando South Mine will be used. Further, commissioning of Kalabasfontein will not add to the production of Forzando South, but will provide relocation areas for existing Forzando South sections.

Kalabasfontein project area is located to the east and south of the existing Forzando South 380MR and Forzando North 381MR respectively which fall within the Msukaligwa Local Municipality. The project area comprises two prospecting rights, 1035PR & 1170PR, which covers a total of approximately 1,548 ha over portions 7, 8, RE, 11 and 13 of the farm Kalabasfontein 232 IS. A new ventilation shaft will be located either on Portion 7 of the farm Uitgedacht 229 IS or on Portion 22 of the farm Uitgedacht 229 IS as part of the Kalabasfontein project.

Environmental authorisation in the form of an Environmental Impact Assessment (EIA) is required for the proposed Kalabasfontein project. As part of the EIA, an Air Quality Specialist Study is required to assess any potential air quality impacts of the proposed project. WSP Environmental (Pty) Ltd has been appointed by Environmental Impact Management Services (Pty) Ltd (EIMS) to undertake an Air Quality Impact Assessment (AQIA) for the proposed Kalabasfontein project in Mpumalanga. Key pollutants associated with the proposed mining activities (material handling, stockpiles, drilling, crushing) were identified as particulate matter of aerodynamic diameters less than 10 and 2.5 microns (PM_{10} and $PM_{2.5}$, respectively).

A baseline assessment was undertaken which included a geographic overview and a review of available meteorological data. In order to characterise the meteorological conditions of the site, local meteorological data was sourced from the Balindi weather station. The station is located approximately 7.4 km to the west-north-west of the Kalabasfontein project. Data recovery from the Balindi station was poor and as such, site-specific modelled MM5 prognostic meteorological data was also obtained for the period January 2015 to December 2017. It is important to note that ambient air quality monitoring data was not available for the project region in order to assess the current air quality situation and as such, concentrations presented in this report are incremental impacts from the Kalabasfontein project only.

The impact assessment comprised of an emissions inventory and subsequent dispersion modelling simulations. An emissions inventory was developed using site-specific data and emission factors which were sourced from either the United States Environmental Protection Agency (USEPA) AP42 (USEPA, 1995) and the Australian Government National Pollutant Inventory (NPI, 2012) database. This emissions inventory was input into a Level Two atmospheric dispersion model, AERMOD, together with prognostic MM5 meteorological data, to calculate ambient air concentrations at specified sensitive receptors of key pollutants associated with the proposed operations. Sensitive receptors are identified as areas that may be impacted negatively due to emissions from the Kalabasfontein Project. Twenty sensitive receptors were identified in the area surrounding the proposed project area, within a 10 km radius, and were used for this assessment.

Activities for the ventilation shaft area during the construction phase was estimated on an area wide basis. The emission rate used to calculate such emissions is environmentally conservative for most construction sites, with results likely being higher than those that will be experienced in reality. Further, it must be emphasised that the construction activities are transient in nature. As such, the construction phase has only been semi-quantitatively assessed.

Long-term (annual) and short-term (24-hour average) concentrations for the pollutants of concern for the operational phase were compared with the applicable National Ambient Air Quality Standards (NAAQS).

Dispersion modelling simulations for the mitigated operational phase indicate that:

— The highest offsite 24-hour average PM_{10} concentrations for 2015 – 2017, 2015, 2016 and 2017 are approximately 232 µg/m^3, 232 µg/m^3, 227 µg/m^3 and 245 µg/m^3 respectively. All predicted concentrations exceed the 24-hour PM_{10} NAAQS of 75 µg/m^3 for each year. This exceedance occurs approximately 2.85 km away from the project boundary at the primary crushing area (i.e. the largest contribution to emissions). However, predicted 24-hour PM_{10} average concentrations for 2015 – 2017, 2015, 2016 and 2017 demonstrate compliance with the 24-hour average PM_{10} NAAQS at all surrounding sensitive receptors. The highest predicted 24-hour concentration of 10.76 µg/m^3 occurred in 2015 at the S7 receptor (**Figure 7-2**);

- The highest offsite period average concentrations for 2015 – 2017, 2015, 2016 and 2017 are approximately 66 µg/m^3, 64 µg/m^3, 70 µg/m^3, and 62 µg/m^3 respectively. All predicted concentrations exceed the annual PM_{10} NAAQS of 40 µg/m^3. This exceedance occurs approximately 2.7 km away from the project boundary at the primary crushing area. However, predicted period and annual PM_{10} average concentrations for 2015, 2016 and 2017 demonstrate compliance with the annual average PM_{10} NAAQS at all surrounding sensitive receptors. The highest predicted PM_{10} annual average concentration of 1.04 µg/m^3 occurred in 2015 at the S7 receptor (**Figure 7-3**);
- The highest offsite 24-hour average $PM_{2.5}$ concentrations for 2015 – 2017, 2015, 2016 and 2017 are approximately 60 µg/m^3, 57 µg/m^3, 60 µg/m^3 and 62 µg/m^3 respectively. All predicted concentrations exceed the 24-hour $PM_{2.5}$ NAAQS of 40 µg/m^3 for each year. This exceedance occurs approximately 2.7 km away from the project boundary at the primary crushing area. However, predicted 24-hour $PM_{2.5}$ average concentrations for 2015 – 2017, 2015, 2016 and 2017 demonstrate compliance with the 24-hour average $PM_{2.5}$ NAAQS at all surrounding sensitive receptors. The highest predicted 24-hour concentration of 2.053 µg/m^3 occurred in 2017 at the S7 receptor (**Figure 7-4**;
- The highest offsite period average concentrations for 2015 – 2017, 2015, 2016 and 2017 are approximately 15 µg/m^3, 14 µg/m^3, 16 µg/m^3, and 14 µg/m^3 respectively. All predicted concentrations demonstrate compliance with the annual $PM_{2.5}$ NAAQS of 20 µg/m^3. Predicted period and annual $PM_{2.5}$ average concentrations for 2015, 2016 and 2017 also demonstrate compliance with the annual average $PM_{2.5}$ NAAQS at all surrounding sensitive receptors. The highest predicted $PM_{2.5}$ annual average concentration of 0.173 µg/m^3 occurred in 2015 at the S7 receptor (**Figure 7-5**); and
- Predicted dust fallout concentrations for 2015 – 2017, 2015, 2016 and 2017 are below the residential standard at all sensitive receptor locations. The highest predicted dust fallout concentration of 483.28 µg/m^3 occurred in 2015-2017 at the S7 receptor. Further, large dust particles do not remain suspended for long distances and are likely to deposit in closer proximity to emission sources. As such, maximum predicted offsite concentrations have not been presented here due to the over estimation of the model, whilst in reality they are likely to be much lower (**Figure 7-6**).

All impacts of the proposed project were evaluated using a risk matrix, which is a semi-quantitative risk assessment methodology. The resultant environmental air quality risks for sensitive receptors were ranked “low” during the construction and operational phases, with mitigation in place (**Table 7-7** and **Table 7-8**).

Based on the findings of the assessment the following mitigation measures would serve to reduce air quality impacts to the receiving environment and sensitive receptors and are detailed further in **Section 7.5**:

CONSTRUCTION PHASE

- Information regarding construction activities should be provided to all local communities. Such information includes:
  - Contact details of a responsible person on site should complaints arise to reduce emissions in a timely manner.
    - Complaints register must be kept to record all events.
- Avoid dust generating works during the most windy conditions;
- When working near (within 100 m) a potential sensitive receptor, limit the number of simultaneous activities to a minimum as far as possible; and
- Wet suppression and wind speed reduction are common methods used to control open dust sources at construction sites as a source of water and material for wind barriers tend to be readily available.

OPERATIONAL PHASE

- **Crushing**
  - As the largest source of emissions from the Kalabasfontein project, it is recommended that dust emissions from crushing be minimised by water sprays and further, by creating a protective berm at the crushing area to serve as a barrier.
- **Conveyor Belts**
  - Conveyors should be enclosed or semi-enclosed (fitted with side wind guards).

  - To prevent unnecessary airborne dust from the conveyors, it is suggested that the conveyor belts are cleaned on a regular basis using belt scrapers or washers.
  - Wetting of conveyor belts has also been found to greatly improve airborne dust concentrations around conveyors.
  - Where it is not economically viable to wet material along transfer points another option is to use non-liquid suppressants.
- **Stockpiles**
  - Permanent stockpiles be enclosed with concrete berms (i.e. a raised barrier made of concrete, separating two areas, which ideally serves as a separation barrier);
  - The height of existing berms at stockpiles be increased, reducing the impact of winds on the stockpile;
  - Temporary stockpiles be enclosed by porous (containing pores) walls; and
  - Small, temporary stockpiles can be covered with a porous sheet (preferably hessian).
- **Drilling and Blasting**
  - Informing nearby residents as to when drilling or blasting will occur on a certain day at a given time; and
  - Not blasting after day-time hours.
- **Unpaved Roads**
- Strict mitigation techniques need to be employed on all unpaved haul roads. The USEPA suggests that vehicle restrictions are one of three categories of mitigation efforts that may be employed to reduce dust emission from unpaved roads. Its recommendations include reducing vehicle speed, reducing vehicle weights and limiting the amount of traffic using the roads.
- It is recommended that all unpaved haul roads and those roads that experience high traffic volumes continue to receive wet suppression, dust-a-side or another form of chemical suppressant (preferably an emulsion type which bonds the soil together). Water can also be applied as a dust suppressant to the unpaved roads.

DECLARATION OF INDEPENDENCE

Novania Reddy is a consultant with over 5 years' experience in the environmental industry. Her area of expertise lies within the air quality and acoustics fields related to sectors ranging from mining to the oil and gas industry. She holds the responsibility of data collection, inventory development, compilation of air emission licence and scientific modelling and reporting. Novania has a broad understanding of the various laws and regulations associated with the air quality and noise procedures.

I hereby declare that I am fully aware of my responsibilities in terms of the National Environmental Management Act: Environmental Impact Assessment Regulations of 2014 and that I have no financial or other interest in the undertaking of the proposed activity other than the imbursement of consultants fees.

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Signature:

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1 INTRODUCTION

Forzando Coal Mines (Pty) Ltd. operates mining operations at both the Forzando North Shaft and Forzando South Shaft in Mpumalanga. Through an intensive drilling exercise on these areas, economically viable blocks of coal have been defined with the intention to access these newly defined blocks of coal from the existing Forzando South incline. As such, a proposed extension of the current mining area is planned, known as the Kalabasfontein project. The Kalabasfontein project will require minimal new surface infrastructure as the mining method to be employed is underground mining and existing surface infrastructure from the Forzando South Mine will be used. Further, commissioning of Kalabasfontein will not add to the production of Forzando South, but will provide relocation areas for existing Forzando South sections.

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1.1 TERMS OF REFERENCE

The terms of reference, designed to best meet the project requirements are summarised below:

— Undertake a baseline assessment of the current meteorological and ambient air quality conditions in the area surrounding the Kalabasfontein project;

— Compilation of a comprehensive emissions inventory for the proposed activities;

— A dispersion modelling investigation using a Level Two (AERMOD) dispersion model to determine the air quality impacts associated with the proposed activities;

— Submission of an AQIA, detailing all findings from the baseline assessment, emissions inventory and dispersion modelling simulations; and

— Provide recommendations on the scope of any mitigation measures that may be applied to reduce the air quality associated with the proposed activities.

2 BACKGROUND

2.1 LOCALITY

The Kalabasfontein project area is situated in Mpumalanga, 20 kilometres north of Bethal. It is located to the east and south of the existing Forzando South 380MR and Forzando North 381MR Mines respectively.

The project area comprises two prospecting rights, 1035PR & 1170PR, which covers a total area of approximately 1,548 ha over portions 7, 8, Remaining Extent (RE), 11 and 13 of the farm Kalabasfontein 232 IS. As part of the Kalabasfontein project, two alternative sites have been proposed for a new ventilation shaft, namely Portion 7 of the farm Uitgedacht 229IS and Portion 22 of the farm Uitgedacht 229 IS. **Figure 2-1** and **Figure 2-2** illustrates the locality map of the Kalabasfontein project area and new proposed ventilation shaft location on Portion 7 and Portion 22, respectively of the farm Uitgedacht 229 IS, whilst **Figure 2-3** shows the Kalabasfontein project in relation to Forzando North and South Coal Mines. Additionally, two powerline alternatives have been proposed for the ventilation shafts, namely; powerline alternative 1 (initial powerline route) and powerline alternative 2 (revised powerline route). However, it must be noted that the powerlines do not impact the air quality study.

2.2 PROJECT DESCRIPTION

Although Kalabasfontein annexation is intended to extend the Life of Mine (LOM) of Forzando South Coal Mine, it will come into production a year after the annexation is granted. The Kalabasfontein project has an estimated LOM of 17 years with the project schedule and timeframe being based on the Forzando South equipment availabilities, efficiencies and both skilled and unskilled labour force. Mining in the Kalabasfontein project area is based on two Continuous Miner (CM) sections.

The access corridor to Kalabasfontein Reserves was identified during exploration drilling. Reserves will be mined through access from one of Forzando South Reserves block. This will eliminate intense preparation work of developing a new incline as there will be infrastructure available at the face.

Currently, Forzando South Mine is scheduled until 2037. However, the Kalabasfontein portion will be mined as soon as permission is granted, in order to ensure sustained production volumes and quantities from the 5 CM sections that are currently being mined. The mine will maintain its production rate of 2.2 Million tonnes (Mt) per annum. Commissioning of Kalabasfontein will not add to the production of Forzando South but will provide relocation areas for existing Forzando South sections. Since the Kalabasfontein project will be mined concurrently with Forzando South, production decline will be due to depletion of Reserves. In the second quarter of year 17 (2037), the first section will pull out and leave the one section to deplete the remaining Reserves.

2.2.1 INFRASTRUCTURE REQUIREMENTS

As the Kalabasfontein project will use the existing Forzando South and Forzando North infrastructure, it is envisaged that additional infrastructure requirements will be minimal. Anticipated demand for water, power and the on-site infrastructure requirements is detailed in the mine works programme (MWP). These requirements are based on staff required over the production period for permanent employees and contractors. Water and electricity requirements for the construction of mine access (ventilation shaft) and surface infrastructure are temporary, lasting for approximately 12 months.

The Forzando North plant is designed to treat run of mine (ROM) of approximately 4.2 Mtpa. This will include coal from the proposed Kalabasfontein Project. The plant will be manned for operations on a 24 hour/day, 7 days/week basis, with the exclusion of statutory public holidays.

Below are plant design parameters used:

- A production of 10,000t per day;
- A production of 3,300t per shift – 3 shift rotation ;
- Feed to ROM bin (peak) of 3,600t per hour at 50mm Top Size;
- ROM material top size (mm): 350mm;

- Primary crusher feed: 1,200t per hour (peak); and
- ROM stockpile surge capacity 10,000t (max): 4,500t (live).

2.2.2 THE MINERAL RESOURCES

The exploration work to date forms the basis for the current evaluation. Between 2006 and 2017, a total of 88 boreholes have been drilled.

Coal measures at Kalabasfontein are hosted within an approximately 160m thick horizon consisting of sandstone and siltstone, subordinate mudstone and shale within the Vryheid Formation of the Ecca Group of the Karoo Super group.

2.2.3 MINING METHOD TO BE EMPLOYED: UNDERGROUND MINING

Bord and pillar mining using CM's was selected as the primary extraction method. In bord and pillar mining, parallel roads are developed in the development direction. Perpendicular roads, called splits, are developed at predetermined intervals to the parallel roads. These roads interlink, creating pillars. The roads mined concurrently are determined by the size of the pillars required to support the overburden above the coal seam and the length of the production equipment trailing cables. Pillar size is determined by the safety factor formula; which is the pillar strength divided by the pillar load (mass of the overburden carried by the pillar). Panel design will be based on either the Probability of Failure (PoF) or the safety factor design criterion. A PoF of 0.1% or SF of 2.0 will be used for main development, whereas a PoF of 1% or SF of 1.6 will be used for production panels depending on the stability and rock engineering characteristics that will be determined by a Rock/Geotechnical Engineer. The dimensions of the roads and the support requirements are determined by a Geotechnical Engineer and documented in a code of practice for the prevention of roof falls.

2.2.4 MINERALS PROCESSING

Although Forzando complex has two mines, namely Forzando North and Forzando South, Kalabasfontein ROM will be crushed at Forzando South prior to conveying to the Forzando North beneficiation plant for processing. Beneficiated coal is railed by means of a rapid loader to Richards Bay Coal Terminal (RBCT) and then shipped from the harbour to clients overseas. All existing surface infrastructure will be retained to service production from Forzando South inclusive of the Kalabasfontein project.

DRY STAGE:

The raw coal is transported from a ROM stockpile by front end loaders and fed into a shallow hopper. The coal is then fed by conveyor to a feeder breaker where the coal is reduced to a size smaller than 400mm before conveyed to a primary crusher for reduction to a size smaller than 75mm. A primary dry screen removes oversize coal (greater than 75mm) for re-crushing and raw duff (smaller than 3mm) for sale or to stockpile while the 75mm x 3mm product is conveyed to a secondary dry screen. The secondary dry screen removes the coal fractions that are larger than 25mm and transfer to a wet screening section, with the coal fragments smaller than 25mm being conveyed to a transfer point for feeding to a surge bin which feeds to the two Heavy Medium Settlers (HMS) plants. Any coal material larger than 75mm is transferred to a secondary crusher for reduction and returned to the circuit.

WET STAGE:

The wet screen section consists of a rinsing screen to remove any retained coal fragments with a size smaller than 6mm, followed by a picking belt to remove obvious waste in the coal material larger than 25mm. The material is then transferred to a final dry screen where the large nuts (45mm – 75mm) and small nuts (25mm – 45mm) are removed. Any undersized coal fragments are returned to the ROM feed point. Note that this stage does not use additives in the water and thus no external pollutants are added. The surge bin can feed separately, or simultaneously, the two washing plants which washes peas (25mm x 6mm or 25mm x 4mm) and duff (6mm x 1mm or 4mm x 1mm) in a cyclone, plus fine coal (1mm x 0.1mm) in the spirals section. Magnetite grains are used as a heavy density medium in the flotation circuit. This is the only additive used in the plant process and has no water pollution potential.

The slurry (smaller than 1.5mm) is piped to a settling pond system (water to solid ratio of 5,7:1) where the water is reclaimed and returned to the washing plant for reuse. Solid discards from the cyclones and spiral plant are hauled to the discard dump for disposal.

2.2.5 RESIDUE STOCKPILES

RUN OF MINE STOCKPILES

As mentioned above, the Kalabasfontein ROM will be crushed at Forzando South prior to conveying to Forzando North beneficiation plant for processing. Beneficiated coal is railed by means of a rapid loader to Richards Bay Coal Terminal (RBCT) and then shipped from the harbour to clients overseas. All existing surface infrastructure will be retained to service production from Forzando South inclusive of Kalabasfontein Project.

NON-CARBONACEOUS STOCKPILES

All discard will be stored on a discard dump and be rehabilitated /cladded as mining progresses. All product coal is stored on existing product stockpiles until it is transported to clients. Forzando North and South operations currently have a ROM coal stockpile and a coal product stockpile as well as a coal discard dump.

CARBONACEOUS STOCKPILES

The only coal waste anticipated is coal that may fall off trucks at the ROM stockpile prior to transportation. This will be collected and transported to the existing Forzando plant off-site.

All product coal is stored on existing product stockpiles until it is transported to clients. ROM coal is beneficiated as produced. An emergency stockpile is provided to cater for situations when beneficiation is not matched with ROM production. This stockpile increases and decreases in volume as “balancing” between the ROM production rate and the beneficiation rate are required.

SOIL STOCKPILES

Before any construction activities are undertaken, the vegetation will be removed, and the topsoil will be stripped and stockpiled. This will apply to the construction of the ventilation shaft. It is anticipated that existing stockpile areas will be used for this purpose.

2.2.6 WASTE

The following types of solid waste will be generated by the proposed Kalabasfontein project:

- Domestic waste;
- Hazardous waste;
- Industrial and mine waste; and
- Mine residue.

The existing Forzando facilities will be utilised to temporarily store waste and all waste will be collected by an approved, registered waste contractor for removal and final disposal. No landfill will be established on the proposed Kalabasfontein project site.

2.2.7 WATER SUPPLY

The proposed Kalabasfontein project will require bulk water for its mining operations as well as domestic water for drinking and ablutions purposes. Bulk water is required for dust suppression and any other mining operations that may require large volumes of water.

2.2.8 CLEAN AND DIRTY WATER SYSTEMS

POLLUTION CONTROL DAMS AND ASSOCIATED DIRTY WATER MANAGEMENT

Forzando South has implemented clean and dirty water management systems. A stormwater diversion trench has been constructed around the offices and workshop areas. All dirty water collected on site is channelled to pollution control dam (PCD) 3 for re-use. All dirty water is to be collected and stored with no discharge to the environment. A surface water monitoring program has been implemented in order to detect any changes in surface water quality. PCD's are de silted on a regular basis in order to maintain the required capacity of the dams. The existing pollution control dams will be used to store wastewater.

2.2.9 BULK POWER SUPPLY

Power is supplied to the mine via a two by 22kV overhead power line to a surface sub-station from where it is transformed to 550V and 400V for surface use and 11KV for underground use. Two powerline alternatives have been proposed for the ventilation shafts, namely; powerline alternative 1 (initial powerline route) and powerline alternative 2 (revised powerline route). However, it must be noted that the powerlines do not impact the air quality study.

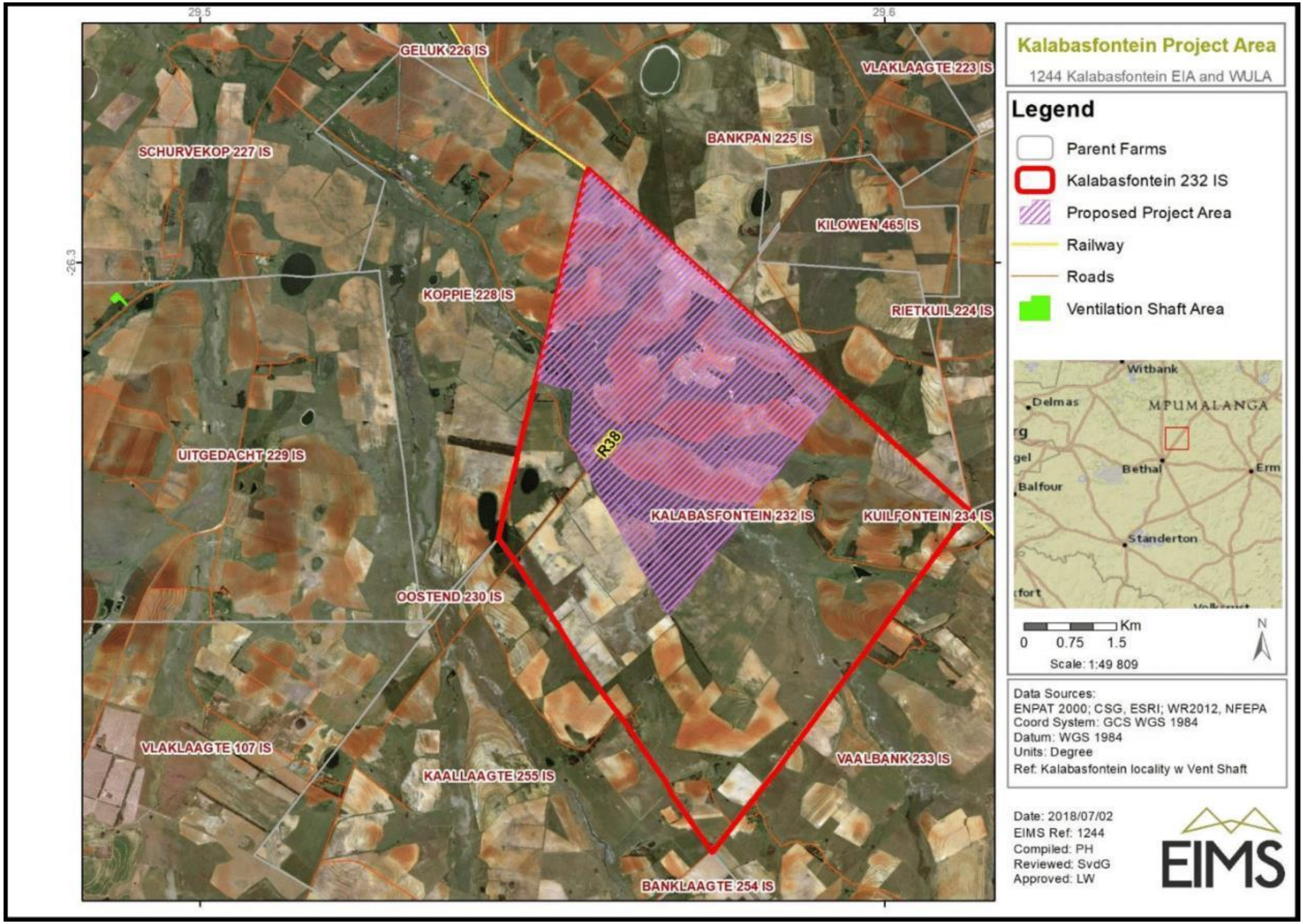

Figure 2-1: Locality map of Kalabasfontein project area and new ventilation shaft on Portion 7 of the farm Uitgedacht 229 IS

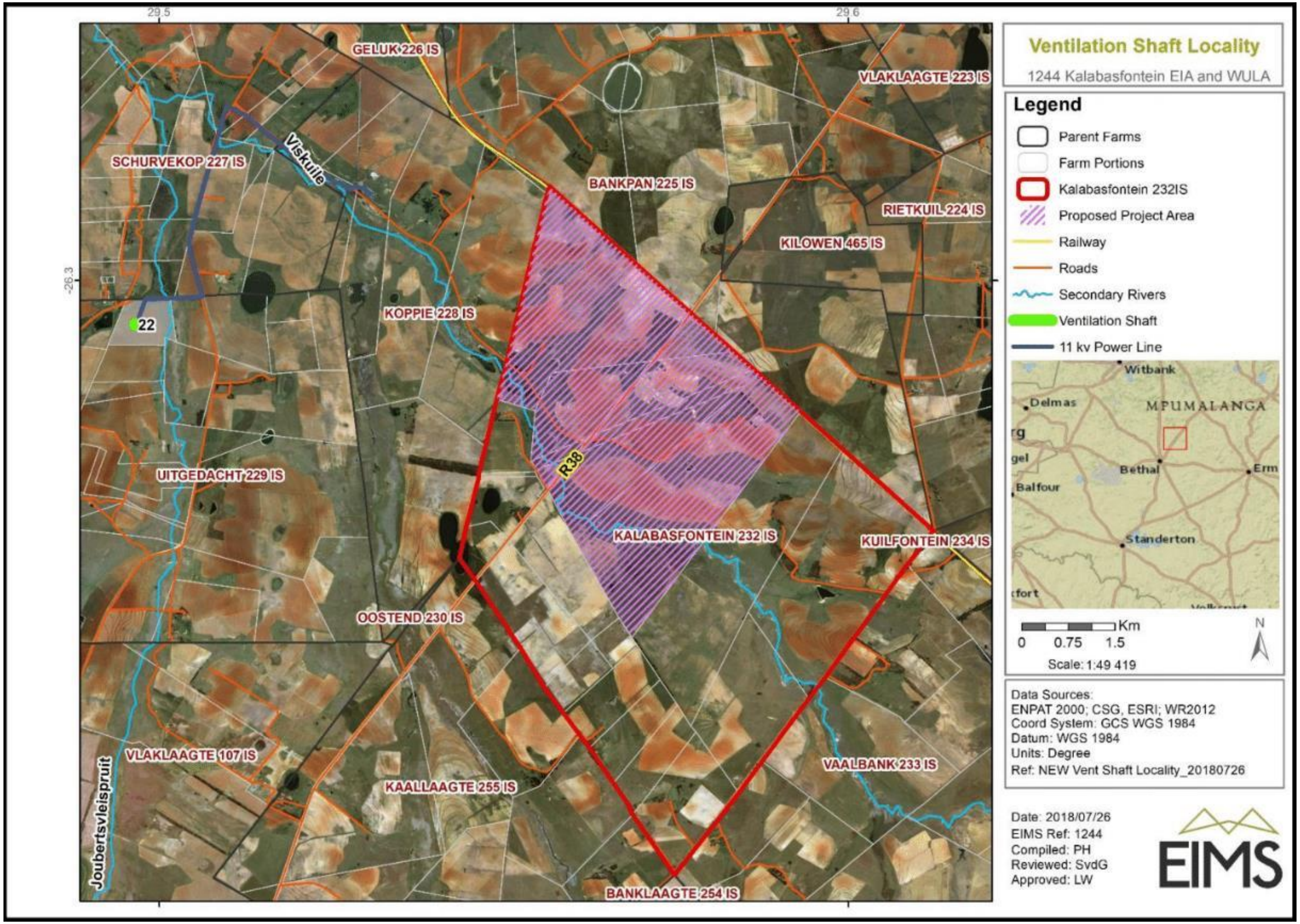

Figure 2-2: Locality map of Kalabasfontein project area and new ventilation shaft on Portion 22 of the farm Uitgedacht 229 IS

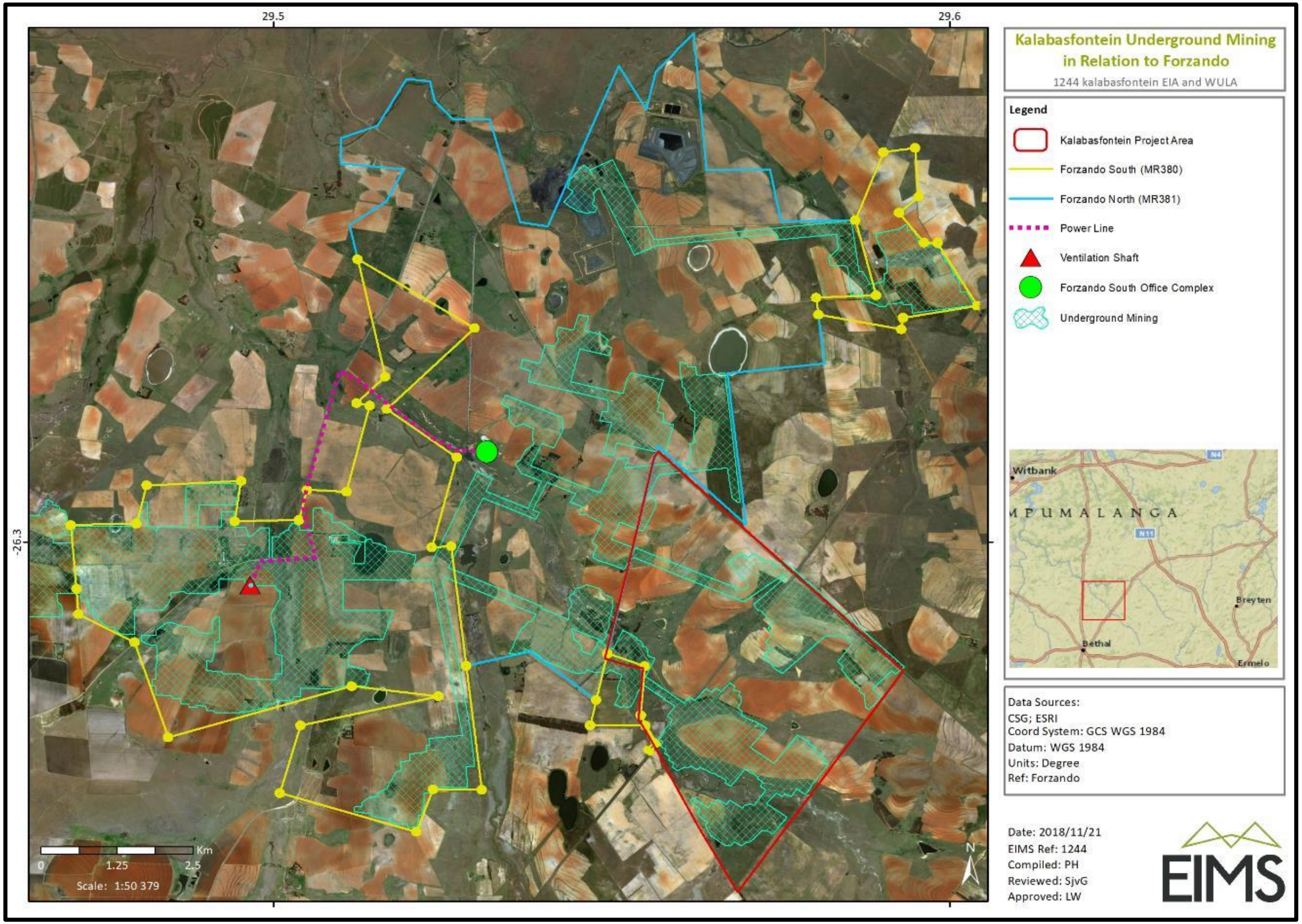

Figure 2-3: Kalabasfontein project area in relation to Forzando North and South

3 ATMOSPHERIC EMISSIONS AND IMPACTS

3.1 HEALTH AND ENVIRONMENTAL IMPACTS

The most significant pollutants associated with mining activities include particulate matter and a description of this has been provided below.

3.1.1 PARTICULATE MATTER

Particulate matter (PM) refers to solid or liquid particles suspended in the air. PM varies in size from particles that are only visible under an electron microscope to soot or smoke particles that are visible to the human eye. PM contributes greatly to deteriorations in visibility, as well as posing major health risks. Small particles (PM_{10}) can penetrate deep into lungs, while even smaller particle sizes ($PM_{2.5}$) can enter the bloodstream via capillaries in the lungs, with the potential to be laid down as plaques in the cardiovascular system or brain. Health effects include respiratory problems, lung tissue damage, cardiovascular problems, cancer and premature death. Acidic particles may damage buildings, vegetation and acidify water sources (USEPA, 2011).

4 LEGISLATIVE FRAMEWORK

4.1 SOUTH AFRICAN AMBIENT AIR QUALITY STANDARDS

The National Environmental Management: Air Quality Act 39 of 2004 (NEM:AQA), which repeals the Atmospheric Pollution Prevention Act (APPA) of 1965, came into effect on 11 September 2005, with the promulgation of regulations in terms of certain sections resulting in the APPA being repealed entirely on 1 April 2010. Key features of the current legislation include:

- A decentralisation of air quality management responsibilities;
- The identification and quantification of significant emission sources that then need to be addressed;
- The development of ambient air quality targets as goals for driving emission reductions;
- The use of source-based (command-and-control) measures in addition to alternative measures, including market incentives and disincentives, voluntary programmes, and education and awareness;
- The promotion of cost-optimized mitigation and management measures;
- Stipulation of air quality management planning by authorities, and emission reduction and management planning by sources; and
- Access to information and public consultation.

The NEM:AQA introduced a management system based on ambient air quality standards (AAQS) and corresponding emission limits to achieve them. Two significant regulations stemming from the NEM:AQA have been promulgated, namely:

- GNR 1210 on 24 December 2009 (Government Gazette 32816) National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) National Ambient Air Quality Standards; and
- GNR 248 on 31 June 2010 (Government Gazette 33064) National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) 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, Ecological Conditions or Cultural Heritage.

The National ambient standards for air quality were based primarily on guidance offered by two standards set by the South African National Standards (SANS), namely:

— SANS 69:2004 Framework for implementing National ambient air quality standards; and

— SANS 1929:2005 Ambient air quality – Limits for common pollutants.

SANS 69:2004 makes provision for the establishment of air quality objectives for the protection of human health and the environment as a whole. Such air quality objectives include limit values, alert thresholds and target values.

SANS1929:2005 uses the provisions in SANS 69 to establish air quality objectives for the protection of human health and the environment, and stipulates that limit values are initially set to protect human health. The setting of such limit values represents the first step in a process to manage air quality and initiate a process to ultimately achieve acceptable air quality Nationally. The limit values presented in this standard are to be used in air quality management but have only become enforceable as revised under GNR 1210 since 24 December 2009. National AAQS for criteria pollutants generally have specific averaging periods; compliance timeframes, permissible frequencies of exceedence and reference methods.

The South African National ambient air quality standards as published in Government Gazette 32816 of 2009 and Government Gazette 35463 of 2012 are summarised in **Table 4-1**.

Table 4-1: South African Ambient Air Quality Standards

Pollutant	Averaging Period	Concentration (µg/m^3)	Frequency of Exceedance
Particulate Matter (PM_{10})	24-hour	75	4
	1 year	40	0
Particulate Matter ($PM_{2.5}$)	24-hour	40	4
	1 year	20	0
Sulphur Dioxide (SO_2)	10-minute	500	526
	1-hour	350	88
	24-hour	125	4
	1 year	50	0
Nitrogen Dioxide (NO_2)	1-hour	200	88
	1 year	40	0
Carbon Monoxide (CO)	1-hour	30,000	88
	8-hour	10,000	11
Benzene (C_6H_6)	1 year	5	0

4.2 DUST FALLOUT STANDARDS

Dust deposition, commonly referred to as dust fallout or nuisance dust is of concern to storage and handling of material and other related operations. National Dust Control Regulations for dust fallout were promulgated in 2013 (Government Gazette 36974). On 25 May 2018, the Minister of Environmental Affairs gave notice to repeal and replace the National Dust Control Regulations (published on 1 November 2013) with new National Dust Control Regulations (Government Gazette 41650). These present acceptable/allowable dust fallout rates for both residential and non-residential areas. These dust fallout standards are expressed in units of mg/m^2/day over a typical 30-day averaging period as presented in **Table 4-2**.

Table 4-2: Acceptable Dust Fallout Limits

Restriction Areas	30 Day Average Dust Fallout (mg/m^2/day)	Permitted Frequency of Exceedance	Reference Method
Residential area	$D < 600$	Twice within a year, not sequential months	ASTM D1739
Non-residential area	$600 < D < 1200$	Twice within a year, not sequential months	ASTM D1739

Any person who conducts an activity that gives rise to dust in quantities that may exceed the standards above must submit a dust monitoring report to the air quality officer (AQO). A schedule for submission of subsequent reports (annually or more frequently) will be approved by the AQO. A dust fallout monitoring report must be submitted by the facility to the AQO if the above standards are exceeded, and within three months of submission of the dust monitoring report, the facility must develop and submit a revised dust management plan to the AQO for approval. Such a plan must:

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

Dust fallout monitoring is currently undertaken at the Forzando South Mine. Dust fallout results are reported on a monthly basis.

5 BASELINE ASSESSMENT

5.1 CLIMATE AND METEOROLOGY

Local data has been sourced from the Balindi weather station. The station is located approximately 7.4 km to the west-north-west of the Kalabasfontein project, with centre coordinates 746808.72 mE, 7086207.41 mS. Only monthly average data was provided from the Balindi station and as such, site-specific modelled MM5 (5^{th}-generation Penn State/NCAR Mesoscale Model) prognostic meteorological data was also obtained for the period January 2015 to December 2017. The United States Environmental Protection Agency (USEPA) AERMET is a meteorological model that generates diagnostic wind field and boundary layer data using MM5 wind fields as part of an objective analysis procedure. For the purposes of this study, an AERMET-ready MM5 dataset was purchased from Lakes Environmental Software. The data coverage is centred over the Kalabasfontein project (anemometer height of 14 m) with a grid cell dimension of 12 km x 12 km over a 50 km x 50 km domain. An analysis of this dataset is presented in the sections below (**Figure 5-1** to **Figure 5-5**).

5.1.1 TEMPERATURE AND RAINFALL

Figure 5-1 and **Figure 5-2** presents the total monthly rainfall and average humidity (where available), while **Figure 5-3** and **Figure 5-4** presents the average, minimum and maximum temperatures, for both the Balindi weather station and for the modelled MM5 data, respectively.

Balindi receives most of its rainfall during the summer months. The total rainfall for 2015, 2016, 2017 and 2018 was 101.50, 268.90, 759.80 and 323.70 mm, respectively. More accurate and distinct patterns are evident with the use of the MM5 data with most of the rainfall being received during the summer months. The total monthly rainfall for 2015, 2016 and 2017 was 688.34, 866.90, and 1003.30 mm, respectively.

No humidity data was available from the Balindi weather station. The modelled MM5 data however, shows that the humidity in the region is moderate to high, with the annual average for 2015, 2016 and 2017 being 69.74, 71.47 and 69.72 %, respectively.

The highest monthly average temperature at Balindi for 2015, 2016, 2017 and 2018 was 25.60, 27.60, 19.50 and 19.30 °C, respectively, recorded during January to March. The lowest monthly average temperature for 2015, 2016, 2017 and 2018 was 7.90, 11.50, 9.40 and 8.50 °C, during May, June and July. It must be noted that temperature data was missing for January, February, June and July. Furthermore, the maximum and minimum temperatures for March were identical, which is highly unlikely. As such, the measurements for March should be viewed with caution. With the use of the modelled MM5 data, the highest monthly average temperature for 2015, 2016 and 2017 was 21.16, 20.14 and 19.32°C, respectively, recorded during summer. The lowest monthly average temperature for 2015, 2016 and 2017 was 8.07, 7.61 and 8.82°C, respectively, recorded during winter.

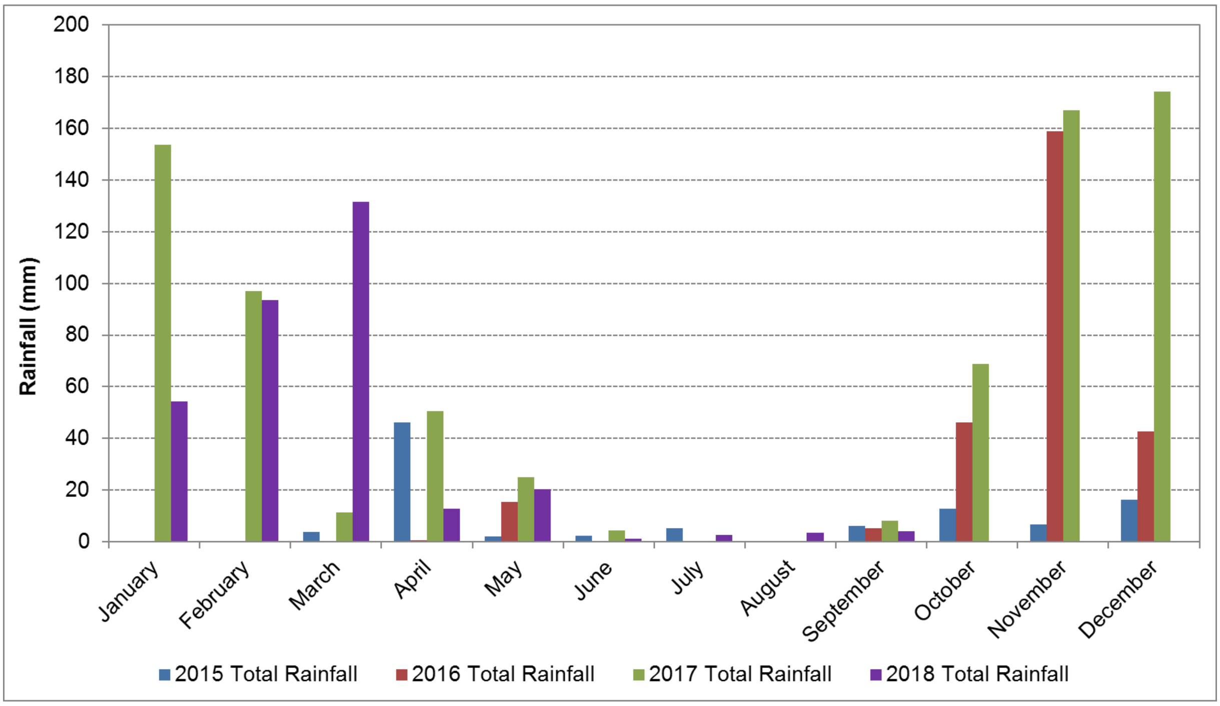

Figure 5-1: Total monthly rainfall at the Balindi weather station for the period January 2015 – September 2018

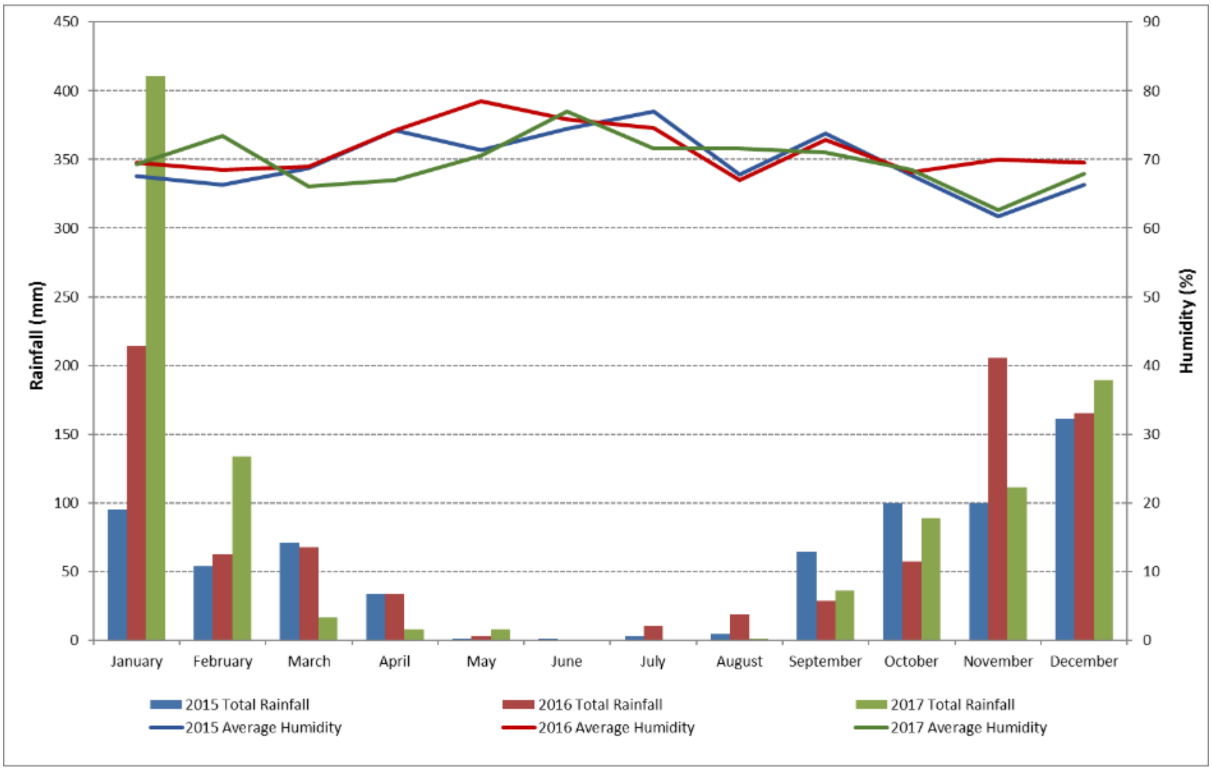

Figure 5-2: Total monthly rainfall using modelled MM5 data for the period January 2015 – December 2017

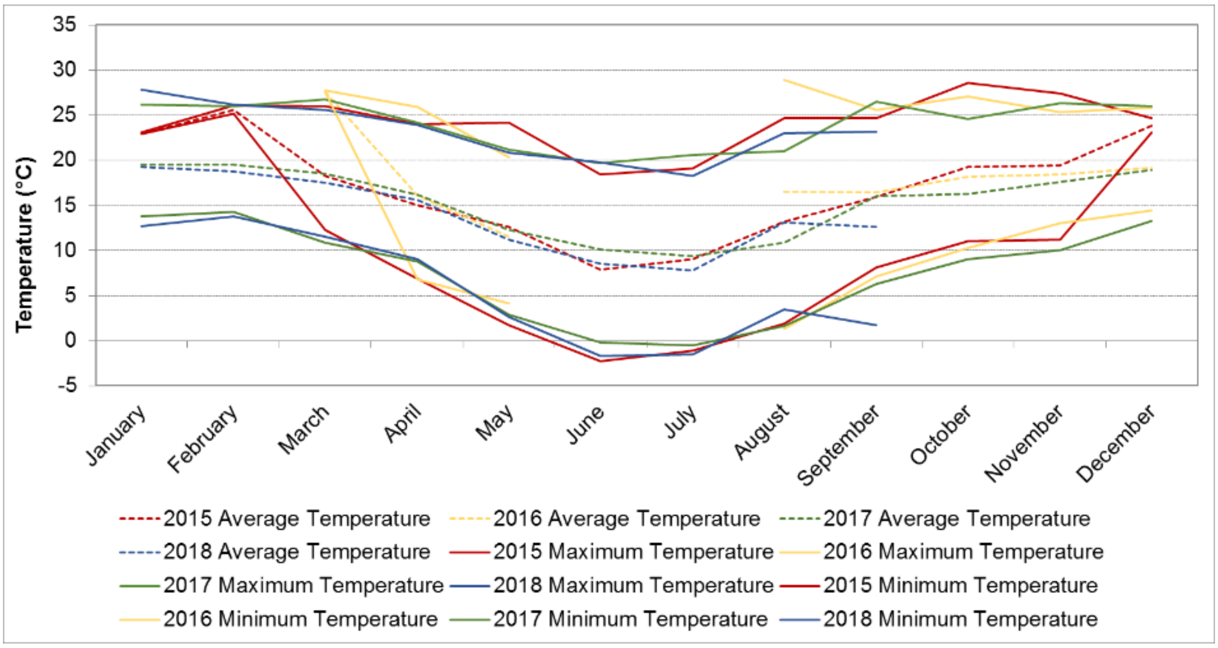

Figure 5-3: Average, maximum and minimum monthly temperatures at the Balindi weather station for the period January 2015 – September 2018

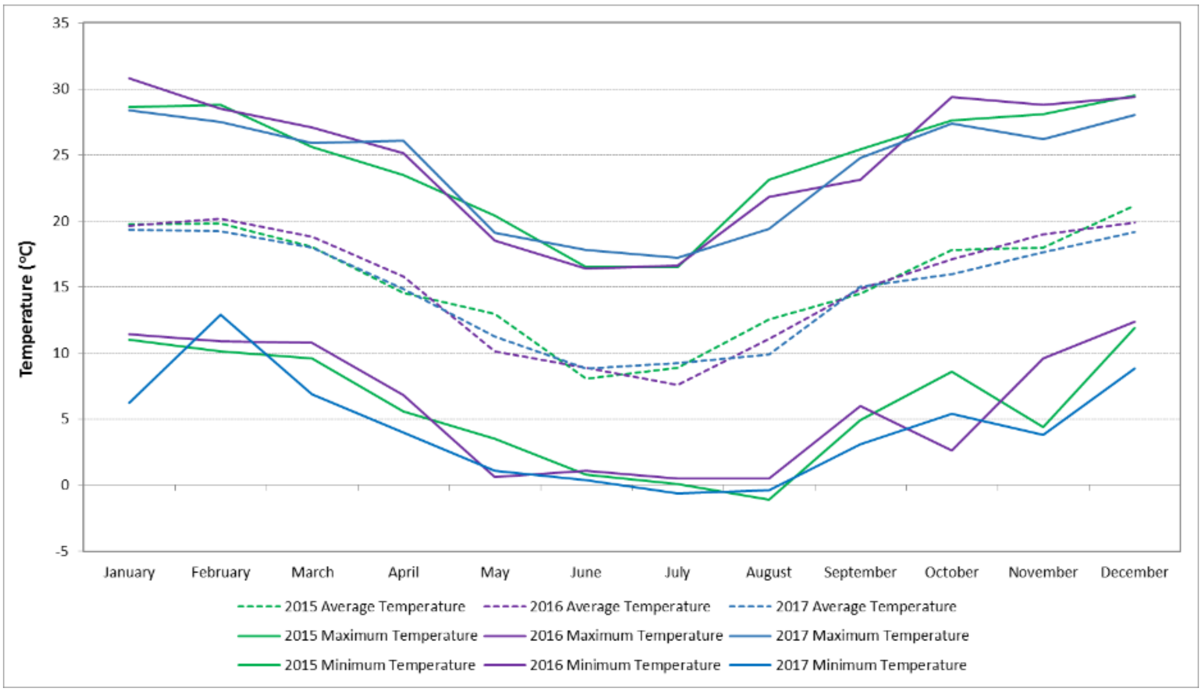

Figure 5-4: Average, maximum and minimum monthly temperatures using modelled MM5 data for the period January 2015 – December 2017

5.1.2 WIND FIELD

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).

Figure 5-5 presents the wind conditions for the surrounding Kalabasfontein project using modelled MM5 data.

The period wind rose using modelled MM5 data (January 2015 to December 2017) presents dominant westerly to easterly wind sectors. Wind speeds are generally moderate, with calm conditions occurring frequently (13.40 % of the time). Diurnal wind flow patterns using modelled MM5 data show moderate winds dominate from the northerly to easterly sectors during 18:00 – 06:00. In the morning and towards the afternoon (06:00 – 18:00), strong north-easterly winds originate, with moderate to fast wind speeds. Modelled MM5 data also show that during summer, autumn and spring westerly to easterly wind sectors prevail. Winter winds, however originate predominantly from the north-westerly region.

Local wind conditions from the Balindi weather station were also provided by the Client. However, only monthly average data was provided for the period January 2015 to September 2018, which limits the accuracy of the data substantially. Additionally, the maintenance frequency and calibration of the station was unknown. As such, the wind data must be viewed with caution and has not been presented here.

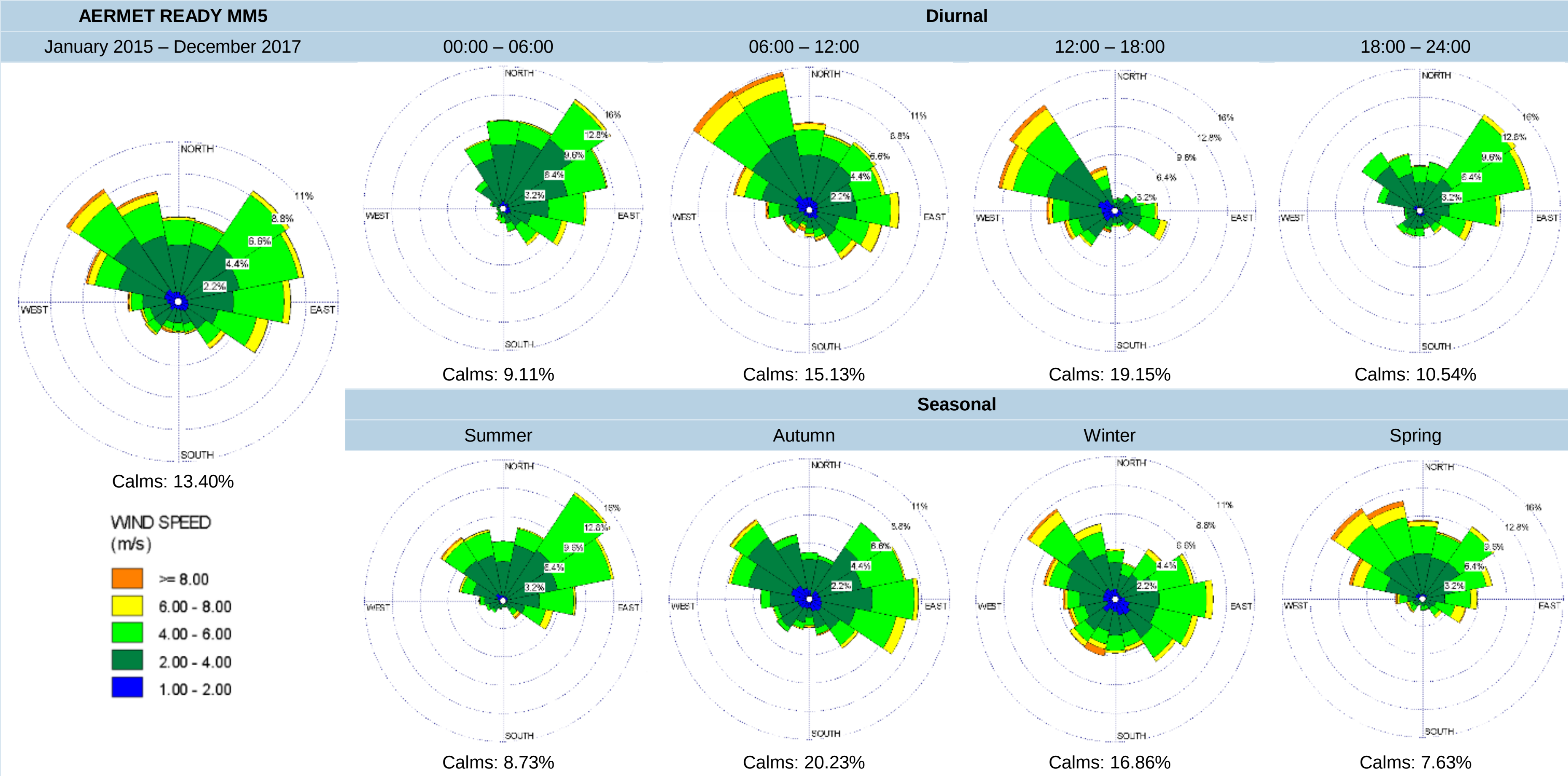

Figure 5-5: Wind conditions using modelled MM5 data for the period January 2015 – December 2017

5.2 AMBIENT AIR QUALITY REVIEW

5.2.1 EXISTING SOURCES OF EMISSIONS

The Kalabasfontein project is located within a rural area, and as such, is surrounded by mining and agricultural activities (**Figure 5-6**). Other sources include vehicle tailpipe emissions along nearby roads, and domestic fuel burning at neighbouring residential areas and settlements.

MINING ACTIVITIES

Mining is one of the predominant land uses within the surrounding area. Several active mines are located within 60 km of the project area and include Taaiboschspruit, Old Leiden, Kusipong, Saymore, Mooiplaats, Ferreira and Penumbra. The mining operations located in the surrounding area can be categorised as open cast and underground operations with surface access nodes. Additional supporting infrastructure is also present and includes mineral processing plants, slurry and co-disposal facilities, conveyor routes, haul roads, offices, pipelines and power lines.

AGRICULTURAL ACTIVITIES

Agriculture is one of the dominant land uses within the surrounding area, comprising mostly monocultures of maize and other small-scale subsistence farming practises. The nearest towns to the proposed mining operation are Hendrina and Bethal, both towns service a community, which is rural in character with farming as the main economic activity. Apple farming in the area between Breyten and Hendrina is also on the increase due to suitable climatic conditions. Although agriculture dominates the physical landscape in Msukaligwa Local Municipality, its contribution to the local economy is relatively small because the product is exported from the area almost entirely in an unbeneficiated form.

Emissions from agricultural activities are difficult to control due to the seasonality of emissions and the large surface area producing emissions (USEPA, 1995). Expected emissions resulting from agricultural activities include particulates associated with wind erosion, ploughing and burning of crop residue, chemicals associated with crop spraying and odiferous emissions resulting from manure, fertilizer and crop residue.

Dust associated with agricultural practices may contain seeds, pollen and plant tissue, as well as agrochemicals, such as pesticides. The application of pesticides during temperature inversions increases the drift of the spray and the area of impact. Dust entrainment from vehicles travelling on gravel roads may also cause increased particulates in an area. Dust from traffic on gravel roads increases with higher vehicle speeds, more vehicles and lower moisture conditions.

These are the most likely contributors of fugitive emissions from agricultural activities. However, it is noted that fugitive emissions from agricultural activities generally have confined impacts near to the source, limiting the regional impacts.

VEHICLE TAILPIPE EMISSIONS

Atmospheric pollutants emitted from vehicles include hydrocarbons, CO, CO_2, NO_x, SO_2 and particulates. These pollutants are emitted from the tailpipe, from the engine and fuel supply system, and from brake linings, clutch plates and tyres. Hydrocarbon emissions, such as benzene, result from the incomplete combustion of fuel molecules in the engine. Carbon monoxide is a product of incomplete combustion and occurs when carbon in the fuel is only partially oxidized to carbon dioxide. Nitrogen oxides are formed by the reaction of nitrogen and oxygen under high pressure and temperature conditions in the engine. Sulphur dioxide is emitted due to the high sulphur content of the fuel. Particulates, such as lead, originate from the combustion process as well as from brake and clutch linings wear (Samaras and Sorensen, 1999).

Possible contributors to mobile combustion emissions include two main roads, namely, R38 and R35, as well as other access roads surrounding the site. Neighbouring communities are likely to use these routes on a daily basis to access the mine and nearby industries for work.

DOMESTIC FUEL BURNING

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 increases with the declining temperature.

Although a high percentage of households are electrified, the burning of coal and wood for heating and cooking purposes still occurs. Even in electrified areas, households continue to make use of domestic fuels due to high electricity costs and the traditional use of such fuels. While electricity is predominantly used, a significant portion of households still make use of gas, paraffin and wood as a fuel source.

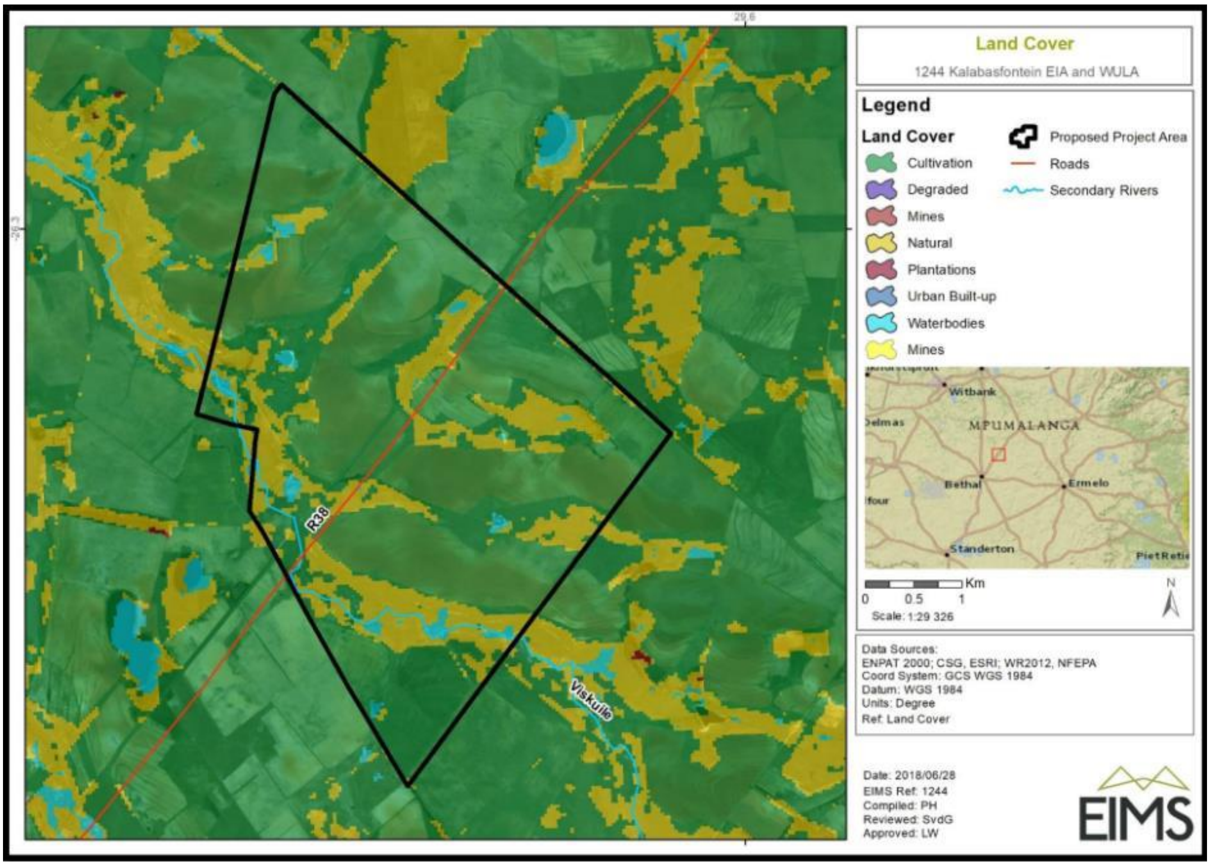

Figure 5-6: Land use surrounding Kalabasfontein

5.2.2 DUST FALLOUT MONITORING

Forzando Coal South Mine currently operates a network of two dust fallout samplers (T1 – 26°17'11.4"S, 29°31'34"E and T2 – 26°17'17"S, 29°31'59"E) with both locations classified as non-residential (**Figure 5-7**). Dust fallout monitoring data was obtained for the period January to December 2017 as presented in **Table 5-1** and illustrated in **Figure 5-8**. Over the monitoring period, dust fallout levels fell below the non-residential standard at all sites. As such, these two sites are compliant with the non-residential standard.

Table 5-1: Dust fallout measurements for the period January 2017 – December 2017

Period	National Non-Residential Standard ($mg/m^2/day$)	T1 ($mg/m^2/day$)	T2 ($mg/m^2/day$)
Jan 2017	**1200**	Contaminated	223
Feb 2017	**1200**	76.2	266
Mar 2017	**1200**	688	Contaminated
Apr 2017	**1200**	206	376
May 2017	**1200**	407	267
June 2017	**1200**	263	448
July 2017	**1200**	275	1021
Aug 2017	**1200**	519	950
Sept 2017	**1200**	820	948
Oct 2017	**1200**	513	1100
Nov 2017	**1200**	858	Contaminated
Dec 2017	**1200**	414	Contaminated
Exceedances		-	-

Figure 5-7: Dust-fallout monitoring locations

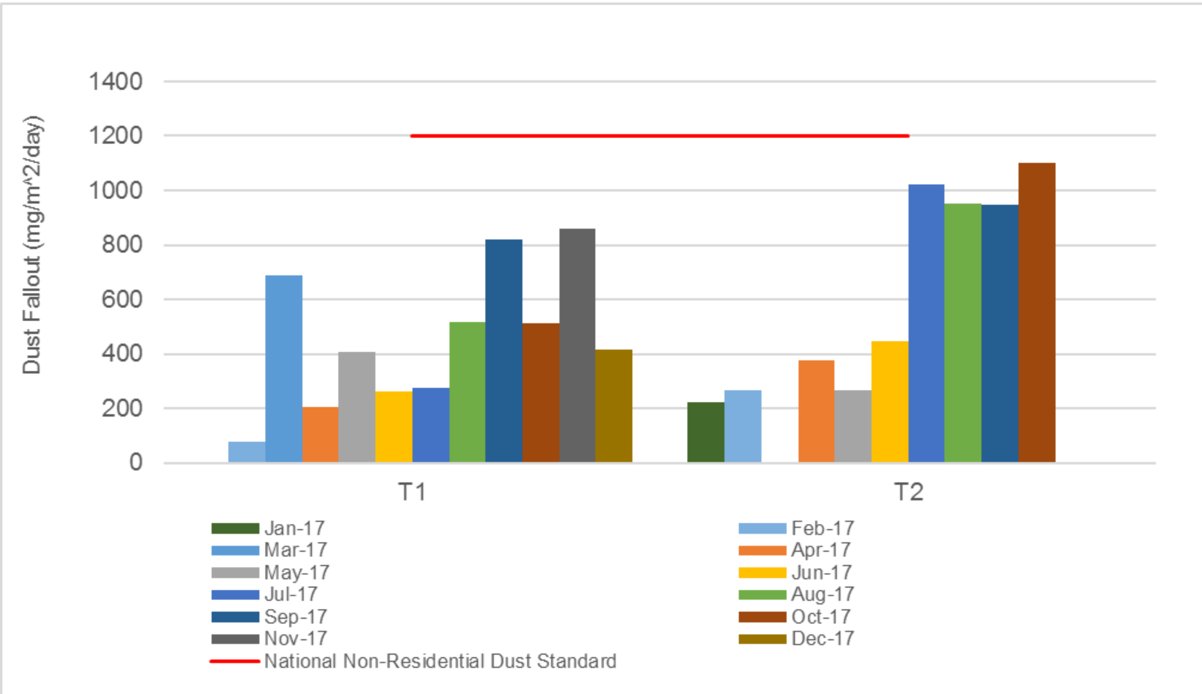

Figure 5-8: Dust-fallout levels for the period January 2017 to December 2018

6 EMISSIONS INVENTORY

6.1 EMISSION ESTIMATION

Emission rates for the proposed activities were calculated using the USEPA AP-42 and the Australian Government National Pollutant Inventory (NPI) emission factors. An emission factor is a value representing the relationship between an activity and the rate of emissions of a specified pollutant. AP-42 emission factors have been compiled since 1972 and contain emission factors and process information for over 200 air pollution source categories. These emission factors have been developed based on test data, material mass balance studies and engineering estimates.

Emission factors are always expressed as a function of the weight, volume, distance or duration of the activity emitting the pollutant. The general equation used for the estimation of emissions is:

$$E = A \times EF \times \left(1 - \frac{ER}{100}\right)$$

Where:

E = emission rate

A = activity rate

EF = emission factor

ER = overall emission reduction efficiency (%)

6.1.1 CONSTRUCTION PHASE

HEAVY CONSTRUCTION

Heavy construction is a source of dust emissions that can have a substantial temporary impact on the local air quality situation. Emissions during construction are associated with land clearing, drilling and blasting, ground excavation and cut and fill operations. Dust emissions often vary substantially on a daily basis, depending on the level of activity, the specific operations and the prevailing meteorological conditions. A large portion of the emissions results from equipment traffic over temporary roads at a construction site (USEPA, 1995).

Construction consists of a series of different operations, each with its own duration and potential for dust generation. Construction operations are of a temporary nature, with a definable beginning and end. Dust emissions vary substantially over different phases of the construction process (USEPA, 1995).

The quantity of dust emissions from construction operations is proportional to the area of land being worked and to the level of construction activity. Emissions from heavy construction are positively correlated with the silt content of the soil and the weight and speed of the average vehicle, and negatively correlated with the soil moisture content (USEPA, 1995).

During construction phase, it is expected that fugitive dust emissions will result from the construction of new ventilation shaft associated with the Kalabasfontein project. Vehicle activities associated with the transport of equipment to and from the site, and on-site construction equipment traffic may also contribute to elevated fugitive dust levels.

Fugitive dust emissions from the construction phase were estimated using the USEPA emission factor for heavy construction activities. The emission factor for construction operations is given as:

$$E = 1.2\ tons/acre/month\ of\ activity$$

The emission factor relates the tonnes of TSP emitted per hectare covered by construction activities per month of activity. The emission factor is most applicable to construction operations with (i) medium activity levels, (ii) moderate silt contents and (iii) semi-arid climates. Based on the USEPA particle size distribution data, PM_{10} and

$PM_{2.5}$ constitute 35% and 5.3% of TSP, respectively. Construction activities were assumed to take place 24 hours per day, 7 days per week.

It must be noted that the emission rate used to calculate such emissions is environmentally conservative (i.e. an overestimation of emissions) for most construction sites, with results presented in this AQIA likely being higher than those that will be experienced in reality. Further, it must be emphasised that the construction activities are transient in nature. As such, the construction phase has only been semi-quantitatively assessed and is presented in **Table 6-1**. It is understood that mitigation methods, such as the use of water, will be in place to suppress dust. As such, emissions presented here are controlled.

Table 6-1: Calculated emission rates for the construction phase

Location	Emission Rate ($g/s/m^2$)		
	TSP	PM_{10}	$PM_{2.5}$
Ventilation shaft area	5.19E-05	1.82E-05	2.75E-06

6.1.2 OPERATIONAL PHASE

WIND EROSION

In the absence of available data regarding the fine material and moisture content of the stockpiles, the default emission factor for TSP and PM_{10} have been applied in accordance with the Australian Government NPI (NPI, 2012). In order to determine the $PM_{2.5}$ emission rate, a factor of 15% was applied to the PM_{10} equation (USEPA, 1995). It is understood that the stockpile will be wetted, as provided by the Client. A control efficiency of 50% for watering was thus applied to the stockpile (NPI, 2012). The emission factor and emission rates for wind erosion are presented in **Table 6-2** and **Table 6-3**.

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Table 6-2: Emission factor for stockpiles

Source	Unit	Emission Factor	
		TSP	PM_{10}
Wind Erosion	kg/ha/hr	0.40	0.20

Table 6-3: Calculated emission rates for stockpiles

Source	Emission Rate (g/s)		
	TSP	PM_{10}	$PM_{2.5}$
Run of Mine (ROM) pad	1.28E-02	6.39E-03	9.58E-04

MATERIAL HANDLING

Emissions from the sequence of material handling events are summarized below:

- Removing overburden/ore
- Offloading overburden/ore at ROM;
- Loading raw coal from ROM onto front end loader (FEL);
- Offloading raw coal from FEL onto hopper;
- Transfer from hopper to conveyor;
- Transfer from conveyor to feeder breaker;
- Transfer from feeder breaker to conveyor; and
- Transfer from conveyor to primary crusher.

The dust emissions from the proposed development has been quantified using the equation below outlined by the USEPA AP42 (USEPA, 1995).

$E = k(0.0016) \times ((U/2.2)^{1.3}/(M/2)^{1.4})$ kg/Mg

Where:

k is the particle size multiplier as detailed in **Table 6-4**, together with the mean wind speed (U) and the material moisture content (M). An average wind speed of 3.26 m/s and a moisture content of 6.9% for coal mining was used. Water will be used to suppress dust for the material handling events, as specified by the Client. Control efficiency of 50% for water sprays and miscellaneous transfer points were applied to the various material handling activities (NPI, 2012). Emission rates for material handling activities are presented in **Table 6-5**.

Table 6-4: Emission parameters for material handling activities

Constant	Symbol	Unit	Emission Factor		
			TSP	PM_{10}	$PM_{2.5}$
Particle Size Multiplier	k	-	0.74	0.35	0.053
Mean Wind Speed	U	m/s	3.26	3.26	3.26
Material Moisture Content	M	%	6.9	6.9	6.9

Table 6-5: Calculated emission rates for material handling activities

Source	Emission Rate (g/s)		
	TSP	PM_{10}	$PM_{2.5}$
Removing overburden/ore	0.93	0.448	0.028
Offloading overburden/ore at ROM	0.45	0.161	0.013
Loading raw coal from ROM onto FEL	0.01	0.006	0.001
Offloading raw coal from FEL onto hopper	0.01	0.006	0.001
Transfer from hopper to conveyor	0.01	0.006	0.001
Transfer from conveyor to feeder breaker	0.01	0.006	0.001
Transfer from feeder breaker to conveyor	0.01	0.006	0.001
Transfer from conveyor to primary crusher	0.01	0.006	0.001

CRUSHING

As specified by the Client, crushing will take place via a primary crusher and will be wetted via water sprays. The emission factor for TSP and PM_{10}, associated with crushing, has been applied in accordance with the USEPA AP42 (USEPA, 1995). The emission factor and rates are shown in **Table** 6-6 and **Table 6-7**. In order to determine the $PM_{2.5}$ emission rates, a factor of 30% was applied to the PM_{10} equation (USEPA, 1995). Controlled efficiencies of 50% for water sprays were applied to the crushing activities (NPI, 2012).

Table 6-6: Emission factors for primary crushing

Constant	Unit	Emission Factor	
		TSP	PM_{10}
Primary Crushing	kg/t	0.01	0.004

Table 6-7: Emission rates for primary crushing

Source	Emission Rate (g/s)		
	TSP	PM_{10}	$PM_{2.5}$
Primary Crushing	0.972	0.389	0.012

DRILLING

Drilling represents intermittent sources of fugitive dust emissions. Drilling activities associated with the proposed development include exploration drilling during the winter months only. Fugitive dust emissions due to drilling operations were quantified using the NPI single-valued emission factor for mining. To determine the dust emissions from drilling activities, an emission factor was applied based on the number of holes that are drilled over a specified time period. The following equation was applied for the drilling:

E = 0.59 kg/hole

The calculation relates the amount of TSP emitted (in kilograms) per hole that is drilled. In order to determine the PM_{10} and $PM_{2.5}$ emission rates, a factor of 52% and 3% was applied respectively to the TSP equation (USEPA, 1995). As specified by the Client, water will be used to mitigate dust during the drilling process. A control efficiency of 70% was hence applied to emissions from drilling (NPI, 2012). Estimated emission rates for drilling are given in **Table 6-8**.

Table 6-8 Estimated parameters and emission rates for drilling

Source	Number of Holes / day	Emission Rate g/s)		
		TSP	PM_{10}	$PM_{2.5}$
Exploration Drilling	0.3	1.48E-03	7.67E-04	4.43E-05

VEHICLE ENTRAINMENT ON UNPAVED ROADS

Resuspended particulate emissions from unpaved roads originate from, and result in the depletion of, the loose material on the road surface (i.e. the surface loading). In turn, that surface loading is continually replenished by other sources. The emission factor for particulate emissions generated by wheel entrainment on unpaved roads is estimated using the following equations:

$$E_{PM10} = \left(1.5\left(\frac{s}{12}\right)^{0.9}\left(\frac{W}{3}\right)^{0.45}\right)(281.9)\ \ g/VKT$$

$$E_{PM2.5} = \left(0.15\left(\frac{s}{12}\right)^{0.9}\left(\frac{W}{3}\right)^{0.45}\right)(281.9)\ \ g/VKT$$

Where:

E = size specific emission factor (g/VKT)

s = surface material silt content (%)

W = mean vehicle weight (tons)

Table 6-9 and **Table 6-10** provide the source parameters and emission rates for unpaved roads. The mean vehicle weight was assumed to be 5 tons. The road has been assumed to be operational for inspection and maintenance purposes only, approximately once a week. The road surface silt content applied for all unpaved roads was the USEPA default value of 10.2% for western surface coal mining haul roads (USEPA, 2006). Since fugitive emissions along roads are mitigated with watering, emissions were assumed to be controlled with an efficiency of 75% (NPI, 2012).

Table 6-9: Source parameters for unpaved roads

Parameter	Length (m)	Width (m)	VKT/day
Access Road 1	970	2.5	0.02
Access Road 2	230	2.5	0.01
Access Road 3	550	2.5	0.01

Table 6-10: Emission rates for wheel entrainment on unpaved roads

Source	Emission Rate ($g/s/m^2$)	
	PM_{10}	$PM_{2.5}$
Access Road 1	5.03E-09	1.26E-09
Access Road 2	5.03E-09	1.26E-09
Access Road 3	5.03E-09	1.26E-09

VENTILATION SHAFTS

A ventilation shaft is proposed for the project via which emissions from the underground activities (the removal of ore and drilling activities) will be emitted into the atmosphere. It is assumed that the total emissions from these activities will be emitted from the ventilation shaft (east and west main fans). The following ventilation shaft parameters were provided by the Client (**Table 6-11**).

Table 6-11: Ventilation shaft parameters and emission rates

Parameter	Unit	Upcast Fans	
		East Main fan	West Main Fan
Length	m	22	22
Diameter	m	3.5	3.5
Height	m	8.2	8.2
Velocity	m/s	8.85	7.74
Flowrate	m^3/s	168.3	157.1
TSP Emission Rate	g/s	0.47	0.47
PM_{10} Emission Rate	g/s	0.22	0.22
$PM_{2.5}$ Emission Rate	g/s	0.01	0.01

7 IMPACT ASSESSMENT

7.1 DISPERSION MODELLING

Atmospheric dispersion modelling mathematically simulates the transport and fate of pollutants emitted from a source into the atmosphere. Sophisticated software with algorithms that incorporate source quantification, surface contours and topography, as well as meteorology can reliably predict the downwind concentrations of these pollutants.

AERMOD, a Level Two dispersion modelling platform, is recommended in the South African Regulations Regarding Air Dispersion Modelling (the Modelling Regulations, Regulation No 533 of 11 July 2014, Government Gazette 37804) and was utilised to predict ground level[1] downwind concentrations of pollutants emitted from the Kalabasfontein project.

AERMOD is a new generation air dispersion model designed for short-range dispersion of airborne pollutants in steady state plumes. It uses hourly sequential meteorological files with pre-processors to generate flow and stability regimes for each hour, that produces output maps of plume spread with key isopleths for visual interpretation. It further enables, through its statistical output, direct comparisons with the latest National and international ambient air quality standards for compliance testing.

The AERMOD atmospheric dispersion modelling system is an integrated system that includes three modules:

— A steady-state dispersion model designed for short-range (up to 50 km) dispersion of air pollutant emissions from stationary industrial sources;

— A meteorological data pre-processor (AERMET) that accepts surface meteorological data, upper air soundings, and optionally, data from on-site instrument towers. It then calculates atmospheric parameters needed by the dispersion model, such as atmospheric turbulence characteristics, mixing heights, friction velocity, Monin-Obukov length and surface heat flux; and

— A terrain pre-processor (AERMAP) whose main purpose is to provide a physical relationship between terrain features and the behaviour of air pollution plumes. It generates location and height data for each receptor location. It also provides information that allows the dispersion model to simulate the effects of air flowing over hills or splitting to flow around hills.

7.1.1 METEOROLOGICAL INPUT

The model was run in accordance with guidance issued by the Modelling Regulations. The meteorological data used by the model to simulate the dispersion and dilution effects generated by the atmosphere were obtained from Lakes Environmental for the years 2015 to 2017, for the Kalabasfontein project. Data describing the topography of the local area was obtained from the Shuttle Radar Topography Mission (SRTM) 1 Arc-Second Global elevation data that offers worldwide coverage of void filled data at a resolution of 1 arc-second (30 meters). **Table 7-1** presents the model input parameters utilised in this assessment.

[1] For the purposes of this assessment, ground-level was used to describe typical receptor breathing height (1.5 m).

Table 7-1: Dispersion model input parameters

Parameter	Model Input
Model	
Assessment Level	Level 2
Dispersion Model	AERMOD
Supporting Models	AERMET and AERMAP
Emissions	
Pollutants modelled	TSP (in the form of dust fallout), PM_{10} and $PM_{2.5}$
Scenario	Proposed operations
Chemical transformation	None
Exponential decay	No
Settings	
Terrain setting	Simple elevated to accommodate for area and volume sources
Terrain data	SRTM30
Terrain data resolution (m)	30
Land characteristics	Rural
Bowen ratio	0.93
Surface albedo	0.29
Surface roughness	0.04
Grid Receptors	
Modelling domain (km)	30 x 30
Property line resolution (m)	50
Fine grid resolution (m)	50 m resolution, 1,000 m from domain centre
Medium grid resolution (m)	100 m resolution, 2,500 m from domain centre
Course grid resolution (m)	250 m resolution, 15,000 m from domain centre

7.1.2 MODELLING DOMAIN

A modelling domain of 30 km × 30 km was used (**Table 7-2**) with multi-tier cartesian grid receptor spacing of 50 m, 100 m and 250 m. The grid spacing selected for the receptor grid is in accordance with those specified in the Regulations Regarding Air Dispersion Modelling.

Table 7-2: Modelling domain coordinates

Domain Point	UTM Coordinates mE	UTM Coordinates mS
North-Western Point	737462.94	7105196.34
North-Eastern Point	767614.09	7105196.34
South-Western Point	737462.94	7075123.71
South-Eastern Point	767614.09	7075123.71

7.1.3 MODEL OUTPUTS

The model output maps and tables that follow show concentrations that would be experienced at 1.5 m above the ground (considered to be representative of average human breathing height). The following statistical outputs were calculated:

— Long-term average is calculated by averaging all hourly concentrations over the modelled period (3 years). Values can be compared with the annual NAAQS to assess likely health impacts across the model domain. The calculation is conducted for each grid point within the modelling domain and at each discrete receptor for every line of meteorological data; and

— 99^{th} percentile (P99) is the 99^{th} percentile concentration of the 24-hour average concentrations for one year or for the entire meteorological period (three years in this study). For example, the 24-hour PM_{10} NAAQS allows for four 24-hour exceedances of the standard per annum at any location. Thus if the P99 24-hour average is lower than the standard, the location can be considered compliant. Although the P99 results are graphically presented in the maps that follow as concentration isopleths, in reality these values do not occur simultaneously across the model domain. Hence the P99 images do not depict a continuous average plume but rather a statistical distribution of the twelfth highest 24-hour average PM_{10} concentrations over the three year modelling period.

As defined in the Modelling Regulations (2014), ambient air quality objectives are applied to areas outside the facility fenceline (i.e. beyond the facility boundary). Within the facility boundary, environmental conditions are prescribed by occupational health and safety criteria. The facility boundary is defined based on these criteria:

The facility fence line or the perimeter where public access is restricted;

— If the facility is located within another larger facility boundary, the facility boundary is the boundary of the encompassing facility; and

— If a public access road passes through the facility, the facility boundary is the perimeter along the road allowance.

7.1.4 SENSITIVE RECEPTORS

Receptors are identified as areas that may be impacted negatively due to emissions from the Kalabasfontein Project. Examples of receptors include, but are not limited to, schools, shopping centres, hospitals, office blocks and residential areas. The sensitive receptors identified in the area surrounding the proposed project area and associated infrastructure are presented in **Table 7-3** and **Figure 7-1**.

Table 7-3: Location of sensitive receptors surrounding the Kalabasfontein project

Receptor	UTM Coordinate		Direction from Site Boundary	Distance from Site Boundary (km)
	mE	mS		
S1	759462.67	7077756.43	South-south-east	2.77
S2	763494.32	7080740.68	East-south-east	4.27
S3	764239.79	7081155.79	East-south-east	4.68
S4	763483.26	7081537.78	East-south-east	3.83
S5	754889.65	7080691.38	South-west	0.80
S6	750695.98	7088718.36	North-west	4.06
S7	753774.89	7089896.51	North-north-west	1.44
S8	756057.84	7090661.98	North	1.03
S9	759283.75	7090225.67	North-north-east	3.08
S10	766576.32	7085047.39	East	5.87
S11	764944.29	7084344.39	East	4.12
S12	763076.18	7083021.33	East-south-east	2.72
S13	758276.77	7079019.13	South-south-east	1.09
S14	757451.52	7079592.25	South-south-east	0.08
S15	756318.77	7077038.85	South	2.02
S16	761368.34	7077503.80	South-south-east	4.70
S17	761502.38	7088564.86	North-east	4.11
S18	761358.31	7092750.10	North-north-east	6.27
S19	753252.28	7086541.64	North-west	1.08
S20	749935.61	7083249.66	West	3.87

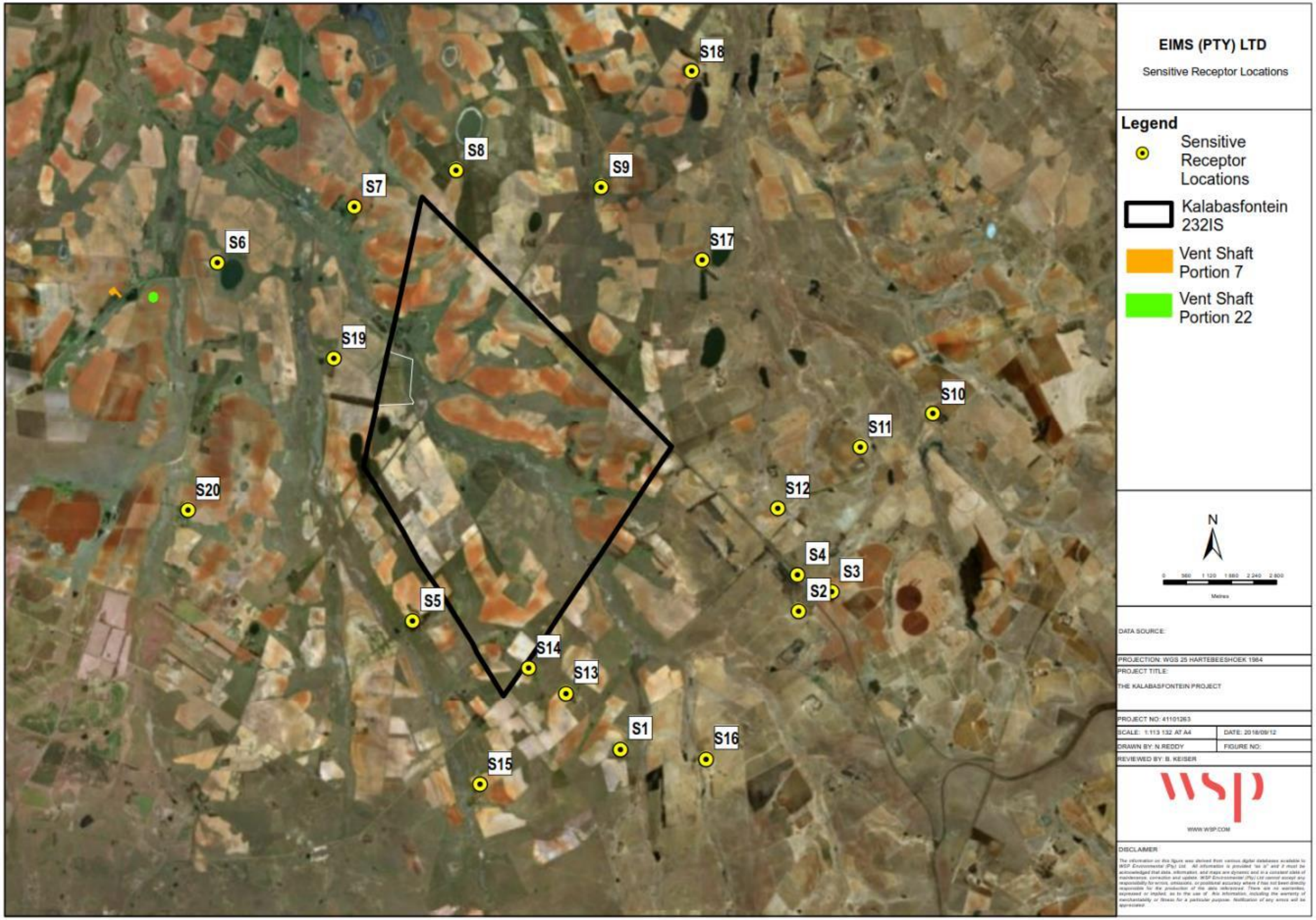

Figure 7-1: Sensitive receptor locations surrounding the Kalabasfontein project area

7.2 MODELLING RESULTS

This section presents the results of the atmospheric dispersion modelling conducted for the mitigated operational phase of the Kalabasfontein project. Concentration results at specified sensitive receptors are presented in tabular format, while concentration isopleths are presented graphically to indicate the dispersion of pollutants. It must be noted that the location of the ventilation shafts did not impact the assessment, producing the same concentrations for both Portion 7 and Portion 22 locations. As such, only one set of results has been presented here.

7.2.1 PM_{10} CONCENTRATIONS

Predicted PM_{10} concentrations associated with operations for the Kalabasfontien project for the highest offsite concentration and at each discrete receptor are presented in **Table 7-4**. **Figure 7-2** and **Figure 7-3** show the plume isopleths for the annual and 24-hour average PM_{10} concentrations for the Kalabasfontein project.

The highest offsite 24-hour average PM_{10} concentrations for 2015 – 2017, 2015, 2016 and 2017 are approximately 232 µg/m^3, 232 µg/m^3, 227 µg/m^3 and 245 µg/m^3 respectively. All predicted concentrations exceed the 24-hour PM_{10} NAAQS of 75 µg/m^3 for each year. This exceedance occurs approximately 2.85 km away from the project boundary at the primary crushing area at the Forzando South Complex (i.e. the largest contribution to emissions). However, predicted 24-hour PM_{10} average concentrations for 2015 – 2017, 2015, 2016 and 2017 demonstrate compliance with the 24-hour average PM_{10} NAAQS at all surrounding sensitive receptors. The highest predicted 24-hour concentration of 10.76 µg/m^3 occurred in 2015 at the S7 receptor.

The highest offsite period average concentrations for 2015 – 2017, 2015, 2016 and 2017 are approximately 66 µg/m^3, 64 µg/m^3, 70 µg/m^3, and 62 µg/m^3 respectively. All predicted concentrations exceed the annual PM_{10} NAAQS of 40 µg/m^3. This exceedance occurs approximately 2.7 km away from the project boundary at the primary crushing area. However, predicted period and annual PM_{10} average concentrations for 2015, 2016 and 2017 demonstrate compliance with the annual average PM_{10} NAAQS at all surrounding sensitive receptors. The highest predicted PM_{10} annual average concentration of 1.04 µg/m^3 occurred in 2015 at the S7 receptor.

7.2.2 $PM_{2.5}$ CONCENTRATIONS

Predicted $PM_{2.5}$ concentrations associated with operations for the Kalabasfontein project for the maximum offsite concentration and at each discrete receptor are presented in **Table 7-5**. **Figure 7-4** and **Figure 7-5** show the plume isopleths for annual and 24-hour average $PM_{2.5}$ concentrations for the Kalabasfontein project.

The highest offsite 24-hour average $PM_{2.5}$ concentrations for 2015 – 2017, 2015, 2016 and 2017 are approximately 60 µg/m^3, 57 µg/m^3, 60 µg/m^3 and 62 µg/m^3 respectively. All predicted concentrations exceed the 24-hour $PM_{2.5}$ NAAQS of 40 µg/m^3 for each year. This exceedance occurs approximately 2.7 km away from the project boundary at the primary crushing area at the Forzando South Complex. However, predicted 24-hour $PM_{2.5}$ average concentrations for 2015 – 2017, 2015, 2016 and 2017 demonstrate compliance with the 24-hour average $PM_{2.5}$ NAAQS at all surrounding sensitive receptors. The highest predicted 24-hour concentration of 2.053 µg/m^3 occurred in 2017 at the S7 receptor.

The highest offsite period average concentrations for 2015 – 2017, 2015, 2016 and 2017 are approximately 15 µg/m^3, 14 µg/m^3, 16 µg/m^3, and 14 µg/m^3 respectively. All predicted concentrations demonstrate compliance with the annual $PM_{2.5}$ NAAQS of 20 µg/m^3. Predicted period and annual $PM_{2.5}$ average concentrations for 2015, 2016 and 2017 also demonstrate compliance with the annual average $PM_{2.5}$ NAAQS at all surrounding sensitive receptors. The highest predicted $PM_{2.5}$ annual average concentration of 0.173 µg/m^3 occurred in 2015 at the S7 receptor.

7.2.3 DUST FALLOUT

Predicted dust fallout concentrations associated with operations for the Kalabasfontein project at each discrete receptor are presented in **Table 7-6**. **Figure 7-6** shows the plume isopleth for the period dust fallout concentrations for the Kalabasfontein project.

Predicted dust fallout concentrations for 2015 – 2017, 2015, 2016 and 2017 are below the residential standard at all sensitive receptor locations. The highest predicted dust fallout concentration of 483.28 µg/m^3 occurred in 2015-2017 at the S7 receptor.

It must be noted that although AERMOD is equipped with algorithms for modelling dry deposition (dust fallout), inherent inaccuracies are associated with the modelling of this pollutant. This is due to many limitations and uncertainties associated with model predicted deposition, such as:

- The complexity of the fluid-dynamic processes that influence the deposition flux.
- The complexity of various deposition surfaces that influence deposition rates.
- Particle-size distributions, which need to be carefully selected for the pollutant of interest.
- Settling velocities, which can vary by three orders of magnitude for various particles.

Further, large dust particles do not remain suspended for long distances and are likely to deposit in closer proximity to emission sources. As such, maximum predicted offsite concentrations have not been presented here due to the over estimation of the model, whilst in reality they are likely to be much lower.

Table 7-4: 24-hour and annual average PM_{10} concentrations predicted at each discrete receptor and maximum offsite concentration

Receptor	24-Hour Av PM_{10} Standard (µg/m³)	24-Hour Average (µg/m³)				Annual Av PM_{10} Standard (µg/m³)	Annual Average (µg/m³)			
		2015 – 2017	2015	2016	2017		2015 – 2017	2015	2016	2017
S1	**75**	1.57	1.86	0.96	1.29	**40**	0.09	0.12	0.07	0.08
S2	**75**	1.38	1.56	0.90	1.35	**40**	0.09	0.11	0.06	0.08
S3	**75**	1.32	1.52	1.02	1.32	**40**	0.08	0.11	0.06	0.08
S4	**75**	1.38	1.66	1.03	1.38	**40**	0.09	0.12	0.06	0.08
S5	**75**	2.18	2.28	2.17	2.09	**40**	0.15	0.19	0.15	0.12
S6	**75**	8.68	6.99	7.64	11.74	**40**	0.85	0.83	0.80	0.92
S7	**75**	10.03	10.76	7.87	10.62	**40**	0.87	1.04	0.67	0.90
S8	**75**	3.96	4.17	3.12	4.51	**40**	0.24	0.30	0.14	0.27
S9	**75**	2.30	2.73	1.13	2.89	**40**	0.12	0.14	0.06	0.15
S10	**75**	1.43	1.43	0.59	1.66	**40**	0.07	0.09	0.04	0.08
S11	**75**	1.53	2.18	0.99	1.39	**40**	0.08	0.11	0.05	0.08
S12	**75**	1.58	1.75	1.12	1.85	**40**	0.10	0.12	0.07	0.09
S13	**75**	1.69	2.23	1.12	1.43	**40**	0.11	0.14	0.08	0.09
S14	**75**	1.98	2.41	1.20	1.49	**40**	0.12	0.17	0.09	0.10
S15	**75**	1.50	1.52	1.65	1.48	**40**	0.10	0.11	0.09	0.09
S16	**75**	1.24	1.33	1.13	1.13	**40**	0.08	0.10	0.07	0.08
S17	**75**	1.86	2.54	1.11	2.35	**40**	0.10	0.11	0.05	0.13
S18	**75**	2.27	2.44	1.46	1.75	**40**	0.09	0.12	0.06	0.09
S19	**75**	4.96	5.10	4.26	5.90	**40**	0.45	0.58	0.39	0.36
S20	**75**	3.92	4.14	3.38	2.56	**40**	0.33	0.43	0.31	0.23
Maximum Offsite Concentration	**75**	**232.00**	**232.00**	**226.80**	**244.72**	**40**	**65.56**	**64.37**	**70.19**	**62.11**

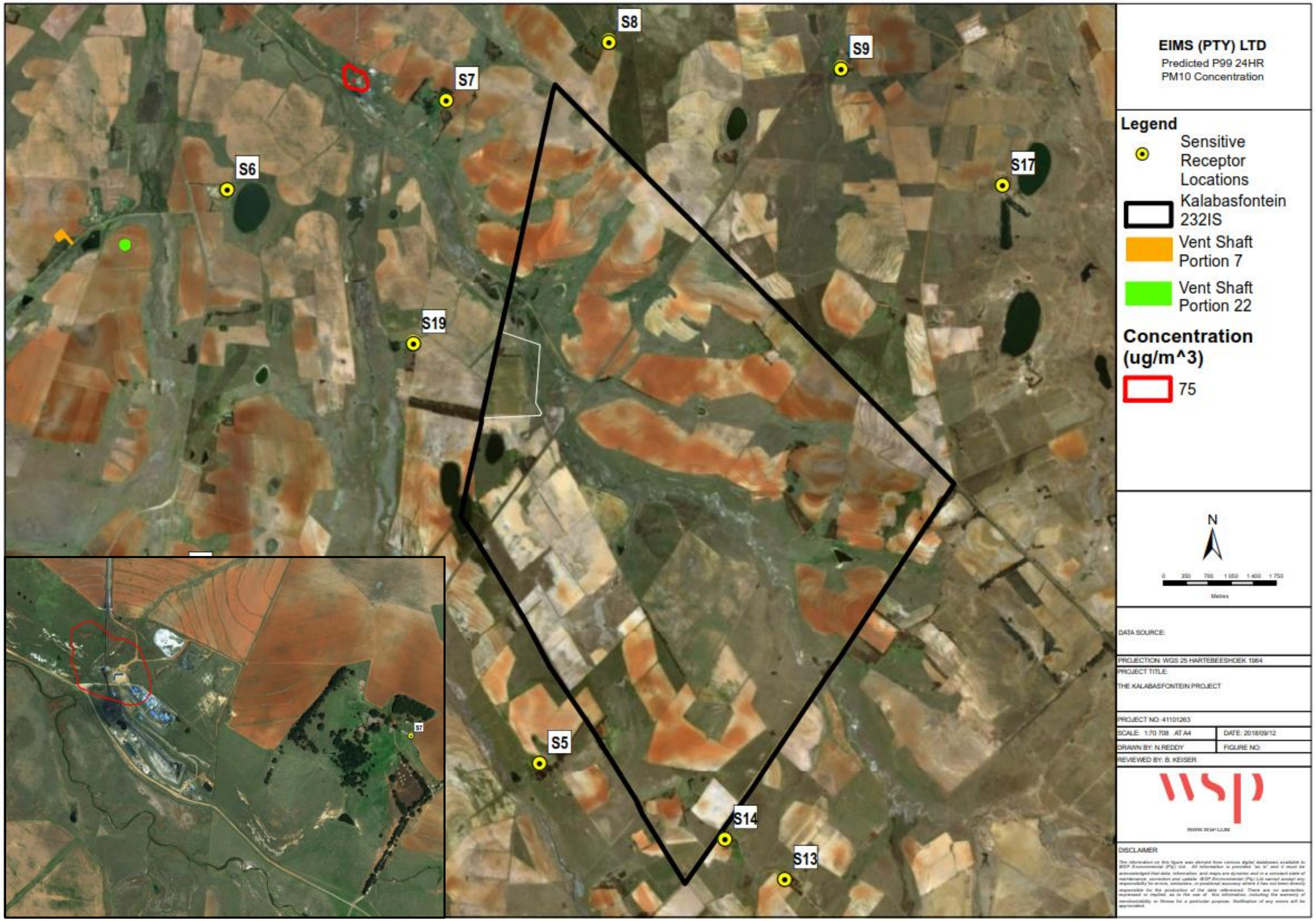

Figure 7-2: Predicted 24-Hour PM_{10} concentrations for the Kalabasfontein project

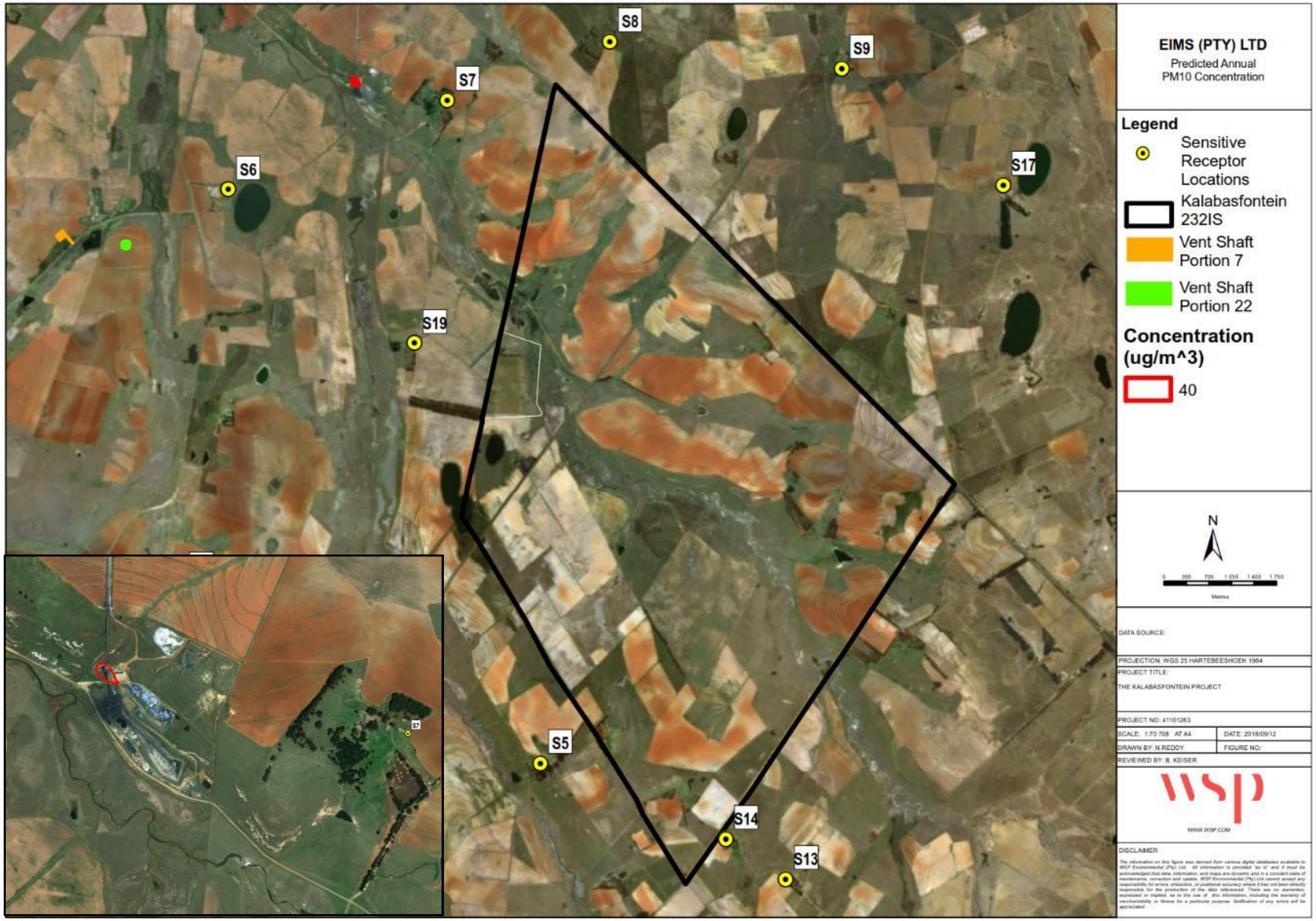

Figure 7-3: Predicted annual PM_{10} concentrations for the Kalabasfontein project

Table 7-5: 24-hour and annual average $PM_{2.5}$ concentrations predicted at each discrete receptor and maximum offsite concentration

Receptor	24-Hour Av $PM_{2.5}$ Standard (µg/m³)	24-Hour Average (µg/m³)				Annual Av $PM_{2.5}$ Standard (µg/m³)	Annual Average (µg/m³)			
		2015 – 2017	2015	2016	2017		2015 – 2017	2015	2016	2017
S1	40	0.128	0.159	0.101	0.093	20	0.009	0.011	0.008	0.008
S2	40	0.141	0.178	0.102	0.162	20	0.009	0.011	0.007	0.009
S3	40	0.174	0.191	0.104	0.201	20	0.009	0.011	0.006	0.009
S4	40	0.184	0.189	0.112	0.202	20	0.010	0.012	0.007	0.010
S5	40	0.149	0.209	0.142	0.138	20	0.014	0.019	0.012	0.010
S6	40	0.869	0.869	0.691	0.969	20	0.087	0.088	0.083	0.089
S7	40	2.003	2.003	1.577	2.053	20	0.142	0.173	0.114	0.139
S8	40	0.650	0.691	0.345	0.688	20	0.031	0.041	0.016	0.035
S9	40	0.262	0.307	0.126	0.436	20	0.015	0.018	0.007	0.020
S10	40	0.169	0.215	0.085	0.169	20	0.008	0.012	0.005	0.008
S11	40	0.213	0.284	0.102	0.214	20	0.010	0.014	0.006	0.009
S12	40	0.233	0.243	0.133	0.244	20	0.011	0.014	0.008	0.012
S13	40	0.162	0.178	0.097	0.117	20	0.011	0.014	0.008	0.009
S14	40	0.158	0.208	0.124	0.126	20	0.012	0.016	0.009	0.010
S15	40	0.111	0.113	0.104	0.095	20	0.009	0.012	0.008	0.007
S16	40	0.146	0.144	0.190	0.154	20	0.009	0.009	0.008	0.008
S17	40	0.243	0.332	0.115	0.337	20	0.012	0.014	0.007	0.015
S18	40	0.250	0.268	0.138	0.163	20	0.011	0.015	0.007	0.011
S19	40	0.471	0.780	0.351	0.403	20	0.045	0.061	0.040	0.033
S20	40	0.283	0.303	0.312	0.248	20	0.026	0.034	0.026	0.019
Maximum Offsite Concentration	40	**60.34**	**57.19**	**60.34**	**62.36**	20	14.58	14.35	15.66	13.74

Figure 7-4: Predicted 24-Hour $PM_{2.5}$ concentrations for the Kalabasfontein project

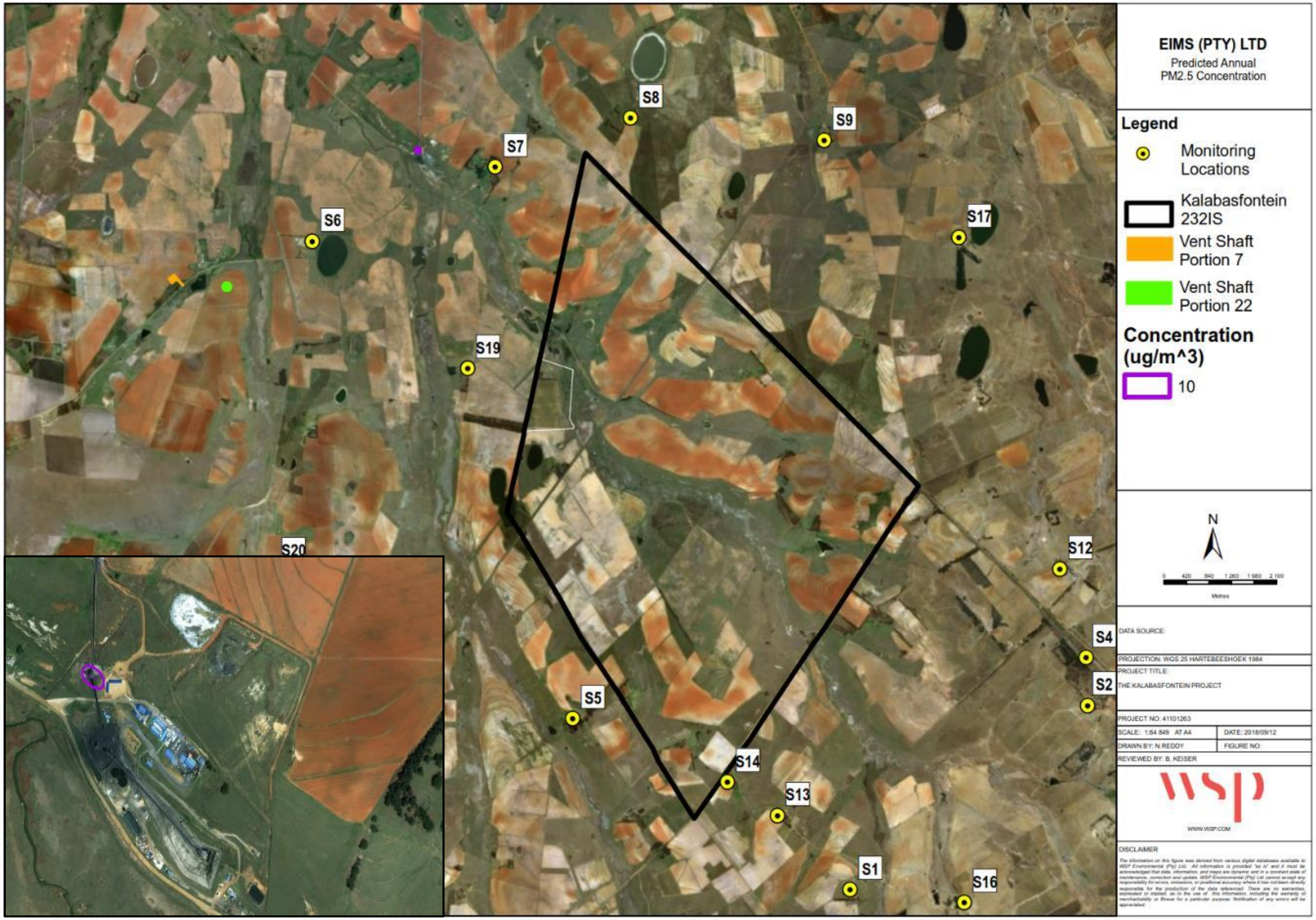

Figure 7-5: Predicted annual $PM_{2.5}$ concentrations for the Kalabasfontein project

Table 7-6: Dust fallout concentrations predicted at each discrete receptor

Receptor	Dust Fallout Standard ($mg/m^2/day$)	Dust Fallout ($mg/m^2/day$)			
		2015 – 2017	2015	2016	2017
S1	**600**	17.92	6.09	5.98	5.84
S2	**600**	15.86	5.59	5.08	5.19
S3	**600**	14.86	5.35	4.83	4.68
S4	**600**	16.12	5.79	5.22	5.11
S5	**600**	31.41	11.83	10.07	9.50
S6	**600**	323.07	107.18	112.19	103.70
S7	**600**	483.28	184.96	144.23	154.10
S8	**600**	44.89	15.76	11.45	17.67
S9	**600**	18.42	6.44	5.03	6.95
S10	**600**	9.85	3.80	3.25	2.79
S11	**600**	12.59	4.78	4.14	3.68
S12	**600**	17.43	6.26	5.77	5.40
S13	**600**	21.56	7.41	7.13	7.03
S14	**600**	24.15	8.46	7.86	7.83
S15	**600**	18.82	6.87	6.31	5.64
S16	**600**	16.05	5.49	5.27	5.29
S17	**600**	14.81	5.41	4.47	4.94
S18	**600**	11.44	4.08	2.78	4.58
S19	**600**	111.53	42.64	37.75	31.14
S20	**600**	66.58	24.60	21.92	20.06

Figure 7-6: Predicted dust fallout concentrations for the Kalabasfontein project

7.3 CUMULATIVE IMPACTS

The National Framework for Air Quality Management in South Africa (DEA, 2014) calls for air quality assessment in terms of cumulative impacts rather than the contributions from an individual facility. The Framework outlines the following for facilities influenced by background sources:

- For annual averages, the sum of the highest predicted concentration (Cp) and the background concentration (Cb) must be less than the NAAQS, no exceedances allowed; and
- For short-term averages (24 hours or less), the sum of the 99^{th} percentile concentrations and background concentrations should be less than the NAAQS.

Monitoring PM data from continuous ambient monitoring stations for the project area was requested, but was however not available at the time of the assessment. As such, cumulative impacts associated with the Kalabasfontein project could not be assessed. Additionally, given the inherent inaccuracies associated with the modelling of dust fallout a cumulative impact assessment was not undertaken for this pollutant. Predicted impacts are therefore limited to incremental impacts.

7.4 ASSUMPTIONS AND LIMITATIONS

- Data input into the model has been based on the information provided by the Client. It is assumed that the information provided by the Client is accurate and complete at the time of modelling;
- In order to determine the $PM_{2.5}$ emission rates for the ROM stockpile, a factor of 15% was applied to the PM_{10} equation and a control efficiency of 50% for watering (as specified by the Client) was applied to the stockpile (NPI, 2012);
- An average wind speed of 3.26 m/s and a moisture content of 6.9% was used for material handling. Control efficiency of 50% for water sprays and miscellaneous transfer points was applied to the various material handling activities, as provided by the Client (NPI, 2012);
- In order to determine the PM_{10} and $PM_{2.5}$ emission rates, a factor of 52% and 3% was applied respectively to the TSP equation for drilling (USEPA, 1995). A control efficiency of 70% for water sprays was applied to emissions from drilling, as provided by the Client;
- In order to determine the $PM_{2.5}$ emission rates for crushing, a factor of 30% was applied to the PM_{10} equation (USEPA, 1995). Controlled efficiencies of 50% for water sprays were applied to the crushing activities (NPI, 2012), as provided by the Client;
- It must be noted the removal of ore and drilling activities take place underground and as such, as a conservative approach, the total emissions from these activities was assumed to be emitted from the ventilation shafts into the atmosphere;
- Material handling and wind erosion operations were assumed to occur 24 hours a day, seven days week. Crushing activities were assumed to be operational for 15 hours a day, seven days a week and drilling was assumed to occur during the winter months only, as provided by the Client;
- Blasting only occurs when a dyke is encountered and for development purposes of the underground workings. Limited information was available as to how often a dyke would be encountered as well as how often blasting would occur for the development of the underground workings and as such, no blasting activities were taken into account for this assessment;
- The impacts in this assessment are limited to incremental impacts as long-term ambient monitoring data was not available to assess future cumulative impacts; and
- Given the inherent inaccuracies associated with the modelling of dust fallout a cumulative impact assessment was not undertaken for this pollutant.

7.5 ASSESSMENT OF IMPACTS

The purpose of this AQIA is to identify the potential impacts and associated risks posed by the construction and operation of the Kalabasfontein project on the air quality of the area. The outcomes of the impact assessment will provide a basis to identify the key risk drivers and make informed decisions on the way forward in order to ensure these risks do not result in unacceptable social or environmental risk.

All impacts of the proposed project were evaluated using a risk matrix, which is a semi-quantitative risk assessment methodology. This system derives an environmental impact level on the basis of the extent, duration, potential intensity and probability of potentially significant impacts. The overall risk level is determined using professional judgement based on a clear understanding of the nature of the impact, potential mitigatory measures that can be implemented and changes in risk profile as a result of implementation of these mitigatory measures. A full description of the risk rating methodology is presented in **Appendix A**. Key localised air quality impacts associated with the expansion include:

- Construction phase impacts of air quality on sensitive receptors; and
- Operational phase impacts of air quality on sensitive receptors.

Outcomes of the air quality impact assessment are contained within **Table 7-7** and **Table 7-8** outlining the impact of each parameter and the resulting risk level. The resultant environmental air quality risks for sensitive receptors were ranked “low” during both the construction and operational phases with mitigation in place (<9 environmental risk).

Table 7-7: Impact assessment of risks associated with the construction for the Kalabasfontein project

Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature	-1	-1	Magnitude	3	2
Extent	3	3	Reversibility	2	2
Duration	1	1	Probability	3	3
Environmental Risk (Pre-mitigation)					-6.75
Mitigation Measures					
Environmental Risk (Post-mitigation)					-6.00
Degree of confidence in impact prediction:					Medium
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					0
#N/A					
Degree of potential irreplaceable loss of resources					1
Low: Where the impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					#N/A
Final Significance					#N/A

Table 7-8: Impact assessment of risks associated with the operations for the Kalabasfontein project

Impact Name	Increase in Air Quality				
Alternative	Alternative 1				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature	-1	-1	Magnitude	3	2
Extent	3	3	Reversibility	3	2
Duration	4	4	Probability	3	3
Environmental Risk (Pre-mitigation)					-9.75
Mitigation Measures					
Environmental Risk (Post-mitigation)					-8.25
Degree of confidence in impact prediction:					Medium
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					0
#N/A					
Degree of potential irreplaceable loss of resources					2
Medium: Where the impact may result in the irreplaceable loss (cannot be replaced or substituted) of resources but the value (services and/or functions) of these resources is limited.					
Prioritisation Factor					1.00
Final Significance					-8.25

7.6 MITIGATION MEASURES

7.6.1 CONSTRUCTION PHASE

The following mitigation measures would serve to reduce air quality impacts to the receiving environment and sensitive receptors:

- Information regarding construction activities should be provided to all local communities. Such information includes:
  - Contact details of a responsible person on site should complaints arise to reduce emissions in a timely manner.
    - Complaints register must be kept to record all events.
- Avoid dust generating works during the most windy conditions;
- When working near (within 100 m) a potential sensitive receptor, limit the number of simultaneous activities to a minimum as far as possible; and
- Wet suppression and wind speed reduction are common methods used to control open dust sources at construction sites as a source of water and material for wind barriers tend to be readily available. General control methods for open dust sources, as recommended by the USEPA, are given in **Table 7-9**.

Table 7-9: Mitigation measures for general construction (USEPA, 1995).

Emission Source	Recommended Control Method
Debris handling	Wind speed reduction
	Wet suppression[(1)]
Truck transport[(2)]	Wet suppression
	Paving
	Chemical stabilisation[(3)]
Bulldozers	Wet suppression[(4)]
Pan scrapers	Wet suppression
Cut/fill material handling	Wind speed reduction
	Wet suppression
Cut/fill haulage	Wet suppression
	Paving
	Chemical stabilisation
General construction	Wind speed reduction
	Wet suppression
	Early paving of permanent roads

Notes:

(1) Dust control plans should contain precautions against watering programs that confound trackout problems.
(2) Loads could be covered to avoid loss of material in transport, especially if material is transported offsite.
(3) Chemical stabilisation usually cost-effective for relatively long-term or semi-permanent unpaved roads
(4) Excavated materials may already be moist and may not require additional wetting.

7.6.2 OPERATIONAL PHASE

GENERAL MITIGATION MEASURES

The Australian NPI recommends a number of ways in which emissions from materials handling and storage activities can be controlled. General control measures and efficiencies are given in **Table 7-10**.

Table 7-10: Emission reduction factors for materials handling and storage (NPI, 2008)

Control Method	Emission Reduction (%)
Wind breaks	30
Water sprays	50
Chemical suppression	80
Enclosure (2 or 3 walls)	90
Covered stockpiles	100

CRUSHING

As the largest source of emissions from the Kalabasfontein project, it is recommended that dust emissions from crushing be minimised by water sprays and further, by creating a protective berm at the crushing area to serve as a barrier.

STOCKPILES

Dust emissions from stockpiles can occur during the loading of the piles, when wind disturbs the stockpile surface, and during reclamation (USEPA, 2006a). Smaller stockpiles can be covered using hessian sheets or alternatively protected by a shade cloth windbreak (porous wall). Both of these techniques aim to reduce wind speed at the surface of the stockpile, in turn reducing the potential for dust scour and entrainment. An important characteristic about wind erosion is that each time a surface is disturbed, its erosion potential is restored.

In order to decrease the erosion potential of stockpiles, the following mitigation techniques are suggested:

- Permanent stockpiles be enclosed with concrete berms;
- The height of existing berms at stockpiles be increased, reducing the impact of winds on the stockpile;
- Temporary stockpiles be enclosed by porous (containing pores) walls; and
- Small, temporary stockpiles can be covered with a porous sheet (preferably hessian).

CONVEYOR BELTS

Wind erosion of material on conveyor belts can cause large quantities of dust to become airborne, particularly if they are open. It is suggested, in order to decrease dust emissions from such a source, that conveyors be enclosed or semi-enclosed (fitted with side wind guards).

Carry-back, the material that sticks to the belt instead of falling off at the head pulley, may also become airborne as the belt dries and passes over the return idlers. If a conveyor belt is not clean, dust can also be bumped from the belt as it passes over the idlers and pulleys, creating more potential for dust to become airborne and entrained in prevailing winds (Kissell, 2003). To prevent unnecessary airborne dust from the conveyors, it is suggested that the conveyor belts are cleaned on a regular basis using belt scrapers or washers. Wetting of conveyor belts has also been found to greatly improve airborne dust concentrations around conveyors. Where it is not economically viable to wet material along transfer points another option is to use non-liquid suppressants.

DRILLING AND BLASTING

Adequate management techniques should be employed. This includes:

- Informing nearby residents as to when drilling or blasting will occur on a certain day at a given time; and
- Not blasting after day-time hours.

UNPAVED ROADS

Strict mitigation techniques need to be employed on all unpaved haul roads. Vehicle movement along unpaved roads manifests a range of dust emission mechanisms. Firstly, as the vehicle's tyres move across the road surface the frictional forces result in the soil and rock particles breaking down into smaller sized particles (which are more readily entrained into the air compared with larger, heavier particles). Air turbulence from the moving tyres, the bulk of the vehicle itself and even the exhaust can result in entrainment of dust which would have otherwise remained on the ground surface. The USEPA suggests that vehicle restrictions are one of three categories of mitigation efforts that may be employed to reduce dust emission from unpaved roads. Its recommendations include reducing vehicle speed, reducing vehicle weights and limiting the amount of traffic using the roads.

It is recommended that all unpaved haul roads and those roads that experience high traffic volumes continue to receive wet suppression, dust-a-side or another form of chemical suppressant (preferably an emulsion type which bonds the soil together), having the benefit of:

- Reducing dust emissions by approximately 99% (dust-a-side);
- Improving safety through improved visibility; and
- Reducing costs associated with application of water to unpaved roads.

In the late 1990s the United States Department of Defence tested various emulsion types of chemical suppressants (polyvinyl acrylic polymer, soybean feedstock by-product, calcium ligno-sulphonate and a 38% calcium chloride solution) to determine the most efficient suppressant (Hough, 2012). Findings indicated:

- Within the first month, all four agents reduced dust emissions by 50%, providing protection to the road surfaces past 60 days, although the polyvinyl acrylic polymer indicated break-up of the surface due to heavy traffic after approximately 45 days (Hough, 2012); and

- In a study conducted in California, the polyvinyl acrylic polymer agent indicated a 90% reduction in fine suspended dust, while a 20% reduction in this dust was noted using ligno-sulphonates and a 10% reduction using calcium chloride (Hough, 2012).

As indicated above, there are various chemical dust suppressants available on the international market, with a number of investigations into the efficiency of these having been conducted. Dust-a-side is a chemical suppressant widely used in South Africa with proven effectiveness and being readily available.

Water can also be applied as a dust suppressant to the unpaved roads. Benefits of application of water include:

- It is environmentally friendly; and
- It is effective in reducing dust emissions for the short-term, for example a large, temporary dust release can be effectively mitigated with the application of water.

The disadvantages of the application of water to unpaved roads include:

- Water is a scare resource and needs to be consumed with care;
- It is a short-term solution, with the road surfaces requiring approximately two applications per day to ensure continued dust suppression;
- On unpaved roads with a high gravel content, the formation of mud will force the gravel to the side of the road, often being lost and requiring replacement with new gravel, at significant costs (Hough, 2012);
- Water does not bind the road surface. Once surfaces are dry, gravel can be thrown up by vehicles causing damage to other vehicles, resulting in higher vehicle maintenance costs;
- The costs associated with water application are high, with numerous tanker trucks required and the associated increased fleet maintenance costs (Hough, 2012); and
- The application of water as a dust suppressant can be viewed negatively by the public as water is viewed as a limited resource.

The use of water as a dust suppressant can be a costly exercise, which is not efficient for the long-term. Alternatives to this suppressant should be investigated, such as those chemical suppressants discussed previously.

In order to adequately mitigate emissions of dust associated with unpaved roads, the following key recommendations are suggested:

- Continued application of dust-a-side or similar chemical suppressant to all unpaved haul roads and other roads experiencing high traffic volumes;
- Application of salts (calcium chloride, magnesium chloride, hydrated lime etc.) which as hygroscopic compounds increase the surface moisture content of the roads material by attracting moisture from the atmosphere;
- Application of surfactants (soaps/detergents) that decrease the surface tension of water allowing the available moisture to wet more particles per unit volume;
- Implement vehicle speed and access restrictions within the site (approximately 10 – 20 km/h);
- Vehicles carrying loose aggregate or soil should be covered with tarpaulins or sheets at all times;
- Prevention of material deposition onto haul roads through avoiding the overloading of truck loads resulting in spillages on the roads; preventing wind erosion from adjacent open areas; and ensure adequate storm water drainage to prevent water erosion of the roads;
- Prioritising source reduction measures through the use of the most direct travel routes on site; undertaking backhauling; using conveyors instead of haul roads where possible; and using larger capacity trucks to minimise the amount of trips; and
- Paving high volume/long term access roads.

8 CONCLUSION

An AQIA for the proposed Kalabasfontein project in Mpumalanga was undertaken. Key pollutants associated with the proposed mining activities (material handling, stockpiles, drilling, crushing) were identified as PM_{10} and $PM_{2.5}$, respectively.

A baseline assessment was undertaken which included a geographic overview and a review of available meteorological data. In order to characterise the meteorological conditions of the site, local meteorological data was sourced from the Balindi City weather station. The station is located approximately 7.4 km to the west-north-west of the Kalabasfontein project. Data recovery from the Balindi City station was poor and as such, site-specific modelled MM5 prognostic meteorological data was also obtained for the period January 2015 to December 2017. It is important to note that ambient air quality monitoring data was not available for the project region in order to assess the current air quality situation and as such, concentrations presented in this report are incremental impacts from the Kalabasfontein project only.

The impact assessment comprised of an emissions inventory and subsequent dispersion modelling simulations. An emissions inventory was developed using site-specific data and emission factors which were sourced from either the USEPA AP42 (USEPA, 1995) or the Australian Government NPI (NPI, 2012) database. This emissions inventory was input into a Level Two atmospheric dispersion model, AERMOD, together with prognostic MM5 meteorological data, to calculate ambient air concentrations at specified sensitive receptors of key pollutants associated with the proposed operations. Sensitive receptors are identified as areas that may be impacted negatively due to emissions from the Kalabasfontein Project. Twenty sensitive receptors were identified in the area surrounding the proposed project area, within a 10 km radius, and were used for this assessment.

Construction activities for the ventilation shaft area during the construction phase was estimated on an area wide basis. The emission rate used to calculate such emissions is environmentally conservative for most construction sites, with results likely being higher than those that will be experienced in reality. Further, it must be emphasised that the construction activities are transient in nature. As such, the construction phase has only been semi-quantitatively assessed.

Long-term (annual) and short-term (24-hour average) concentrations for the pollutants of concern for the operational phase were compared with the applicable NAAQS.

Dispersion modelling simulations for the mitigated operational phase indicate that:

- The highest offsite 24-hour average PM_{10} concentrations for 2015 – 2017, 2015, 2016 and 2017 are approximately 232 µg/m^3, 232 µg/m^3, 227 µg/m^3 and 245 µg/m^3 respectively. All predicted concentrations exceed the 24-hour PM_{10} NAAQS of 75 µg/m^3 for each year. This exceedance occurs approximately 2.85 km away from the project boundary at the primary crushing area (i.e. the largest contribution to emissions). However, predicted 24-hour PM_{10} average concentrations for 2015 – 2017, 2015, 2016 and 2017 demonstrate compliance with the 24-hour average PM_{10} NAAQS at all surrounding sensitive receptors. The highest predicted 24-hour concentration of 10.76 µg/m^3 occurred in 2015 at the S7 receptor;
- The highest offsite period average concentrations for 2015 – 2017, 2015, 2016 and 2017 are approximately 66 µg/m^3, 64 µg/m^3, 70 µg/m^3, and 62 µg/m^3 respectively. All predicted concentrations exceed the annual PM_{10} NAAQS of 40 µg/m^3. This exceedance occurs approximately 2.7 km away from the project boundary at the primary crushing area. However, predicted period and annual PM_{10} average concentrations for 2015, 2016 and 2017 demonstrate compliance with the annual average PM_{10} NAAQS at all surrounding sensitive receptors. The highest predicted PM_{10} annual average concentration of 1.04 µg/m^3 occurred in 2015 at the S7 receptor;
- The highest offsite 24-hour average $PM_{2.5}$ concentrations for 2015 – 2017, 2015, 2016 and 2017 are approximately 60 µg/m^3, 57 µg/m^3, 60 µg/m^3 and 62 µg/m^3 respectively. All predicted concentrations exceed the 24-hour $PM_{2.5}$ NAAQS of 40 µg/m^3 for each year. This exceedance occurs approximately 2.7 km away from the project boundary at the primary crushing area. However, predicted 24-hour $PM_{2.5}$ average concentrations for 2015 – 2017, 2015, 2016 and 2017 demonstrate compliance with the 24-hour average $PM_{2.5}$ NAAQS at all surrounding sensitive receptors. The highest predicted 24-hour concentration of 2.053 µg/m^3 occurred in 2017 at the S7 receptor;
- The highest offsite period average concentrations for 2015 – 2017, 2015, 2016 and 2017 are approximately 15 µg/m^3, 14 µg/m^3, 16 µg/m^3, and 14 µg/m^3 respectively. All predicted concentrations demonstrate compliance with the annual $PM_{2.5}$ NAAQS of 20 µg/m^3. Predicted period and annual $PM_{2.5}$ average

concentrations for 2015, 2016 and 2017 also demonstrate compliance with the annual average $PM_{2.5}$ NAAQS at all surrounding sensitive receptors. The highest predicted $PM_{2.5}$ annual average concentration of 0.173 µg/m^3 occurred in 2015 at the S7 receptor; and

- Predicted dust fallout concentrations for 2015 – 2017, 2015, 2016 and 2017 are below the residential standard at all sensitive receptor locations. The highest predicted dust fallout concentration of 483.28 µg/m^3 occurred in 2015-2017 at the S7 receptor. Further, large dust particles do not remain suspended for long distances and are likely to deposit in closer proximity to emission sources. As such, maximum predicted offsite concentrations have not been presented here due to the over estimation of the model, whilst in reality they are likely to be much lower.

All impacts of the proposed project were evaluated using a risk matrix, which is a semi-quantitative risk assessment methodology. The resultant environmental air quality risks for sensitive receptors were ranked “low” during the construction and operational phases, with mitigation in place.

Based on the findings of the assessment the following mitigation measures would serve to reduce air quality impacts to the receiving environment and sensitive receptors and are detailed further in **Section 7.5**:

CONSTRUCTION PHASE

- Information regarding construction activities should be provided to all local communities. Such information includes:
  - Contact details of a responsible person on site should complaints arise to reduce emissions in a timely manner.
    - Complaints register must be kept to record all events.
- Avoid dust generating works during the most windy conditions;
- When working near (within 100 m) a potential sensitive receptor, limit the number of simultaneous activities to a minimum as far as possible; and
- Wet suppression and wind speed reduction are common methods used to control open dust sources at construction sites as a source of water and material for wind barriers tend to be readily available.

OPERATIONAL PHASE

- **Crushing**
  - As the largest source of emissions from the Kalabasfontein project, it is recommended that dust emissions from crushing be minimised by water sprays and further, by creating a protective berm at the crushing area to serve as a barrier.
- **Conveyor Belts**
  - Conveyors should be enclosed or semi-enclosed (fitted with side wind guards).
  - To prevent unnecessary airborne dust from the conveyors, it is suggested that the conveyor belts are cleaned on a regular basis using belt scrapers or washers.
  - Wetting of conveyor belts has also been found to greatly improve airborne dust concentrations around conveyors.
  - Where it is not economically viable to wet material along transfer points another option is to use non-liquid suppressants.
- **Stockpiles**
  - Permanent stockpiles be enclosed with concrete berms;
  - The height of existing berms at stockpiles be increased, reducing the impact of winds on the stockpile;
  - Temporary stockpiles be enclosed by porous walls; and
  - Small, temporary stockpiles can be covered with a porous sheet (preferably hessian).
- **Drilling and Blasting**
  - Informing nearby residents as to when drilling or blasting will occur on a certain day at a given time; and
  - Not blasting after day-time hours.
- **Unpaved Roads**
- Strict mitigation techniques need to be employed on all unpaved haul roads. The USEPA suggests that vehicle restrictions are one of three categories of mitigation efforts that may be employed to reduce dust emission

from unpaved roads. Its recommendations include reducing vehicle speed, reducing vehicle weights and limiting the amount of traffic using the roads.

- It is recommended that all unpaved haul roads and those roads that experience high traffic volumes continue to receive wet suppression, dust-a-side or another form of chemical suppressant (preferably an emulsion type which bonds the soil together). Water can also be applied as a dust suppressant to the unpaved roads.

SPECIALIST DECLARATION

DETAILS OF THE SPECIALIST, DECLARATION OF INTEREST AND UNDERTAKING UNDER OATH

Application for authorisation in terms of the National Environmental Management Act, Act No. 107 of 1998, as amended and the Environmental Impact Assessment (EIA) Regulations, 2014, as amended (the Regulations)

PROJECT TITLE

Air Quality Impact Assessment for the Kalabasfontein Project

1. SPECIALIST INFORMATION

Specialist Company Name:	WSP Environmental (Pty) Ltd			
B-BBEE	Contribution level (indicate 1 to 8 or non-compliant)	Level 5	Percentage Procurement recognition	
Specialist name:	Novania Reddy			
Specialist Qualifications:	BSc. Chemical Engineering			
Professional affiliation/registration:	N/A			
Physical address:	Building C Knightsbridge 33 Sloane Street Bryanston 2191 South Africa			
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Telephone:	+27 11 361 1371	Fax:	-	
E-mail:	novania.reddy@wsp.com			

2. DECLARATION BY THE SPECIALIST

I, Novania Reddy, declare that –

- 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.

Signature of the Specialist

WSP Environmental (Pty) Ltd

Name of Company:

12 November 2019

Date

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APPENDIX

A

IMPACT ASSESSMENT METHODOLOGY

APPENDIX

Method of Assessing Impacts:

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

Determination of Environmental Risk:

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

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

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

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

Each individual aspect in the determination of the consequence is represented by a rating scale as defined in the table below.

Criteria for Determining Impact Consequence

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

APPENDIX

Once the C has been determined the ER is determined in accordance with the standard risk assessment relationship by multiplying the C and the P. Probability is rated/scored as below.

Probability Scoring

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

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

ER= C x P

Determination of Environmental Risk

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

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

Significance Classes

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

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

Impact Prioritisation:

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

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

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

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

Criteria for Determining Prioritisation

Public response (PR)	Low (1)	Issue not raised in public response.
	Medium (2)	Issue has received a meaningful and justifiable public response.
	High (3)	Issue has received an intense meaningful and justifiable public response.

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

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

Priority = PR + CI + LR

The result is a priority score which ranges from 3 to 9 and a consequent PF ranging from 1 to 2.

Determination of Prioritisation Factor

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

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

Final Environmental Significance Rating

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