APPENDIX I: AIR QUALITY STUDY

Jindal Melmoth Iron Ore Mine

Air Quality Impact Assessment Report

SLR Consulting

J21066

Date:17 March 2023

Report Approval & Revision Record

Project:	Jindal Melmoth Iron Ore Mine			
Document Title:	Air Quality Impact Assessment Report			
Client:	SLR Consulting			
Report Number:	J21066			
Rev	**Date**	**Prepared**	**Reviewed**	**Approved**
01	14 November 2022	Shazelle James Environmental Consultant	Marc Blanché Partner	Marc Blanché Partner
02	03 March 2023	Shazelle James Environmental Consultant	Marc Blanché Partner	Marc Blanché Partner
03	17 March 2023	Shazelle James Environmental Consultant	Marc Blanché Partner	Marc Blanché Partner

Table of Contents

List of Tables

List of Figures

Acronyms

Units of Measurement

%	Percentage
ha	Hectares
km	Kilometres
kV	Kilovolt
l	Litre
lb/VMT	Pounds per vehicle mile travelled
m	Metres
ml	Millilitres
mm	Millimetre
m/s	Metres per second
m E	Meters East
m S	Metres South
mg/Nm^3	Milligrams per normal metres cubed
$mg/m^2/day$	Milligram per square metre per day
mtpa	Million tonnes per annum
µm	Micrometre
$µg/m^3$	Microgram per cubic metre

Chemical Compounds

CO	Carbon Monoxide
Fe	Iron
NO_2	Nitrogen Dioxide
SO_2	Sulphur Dioxide
PM	Particulate Matter
PM_{10}	Particulate Matter (Particle Size Fraction < 10 µm)
$PM_{2.5}$	Particulate Matter (Particle Size Fraction < 2.5 µm)

General

AAQS	Ambient Air Quality Standards

ADM	Air Dispersion Model
ASTM	American Society of Testing and Materials
AQIA	Air Quality Impact Assessment
AQMS	Air Quality Monitoring Station
BFS	Bankable Feasibility Study
DFFE	Department of Forestry, Fisheries and Environment
DMR EDTEA	Department of Economic Development, Tourism and Environmental Affairs
EAP	Environmental Assessment Practitioner
EIA	Environmental Impact Assessment
ESIA	Environmental and Social Impact Assessment
GLC	Ground Level Concentration
HPGR	High Pressure Grinding Roll
I&APs	Interested and Affected Parties
IFC	International Finance Corporation
KZN	KwaZulu-Natal
MRA	Mining Right Application
NAAQS	National Ambient Air Quality Standards
NEM: AQA	National Environmental Management Air Quality Act
NPI	National Pollution Inventory
PP	Public Participation
PSD	Particle Size Distribution
RBCAA	Richards Bay Clean Air Association
ROM	Run-of-Mine
SAAQIS	South African Air Quality Information System
SRTM	Shuttle Radar Topography Mission
SR	Sensitive Receptor
TSF	Tailings Storage Facility
TSP	Total Suspended Particles
US EPA	United States Environmental Protection Agency

UTM	Universal Transverse Mercator
VMT	Vehicle Mile Travelled
WRD	Waste Rock Dump
WHO	World Health Organisation
WKC	WKC Group (Pty) Ltd
WRF	Weather Research and Forecasting

1 Facility and Modeller's Information

1.1 Project Identification Information

SLR Consulting (hereafter referred to as the "Client"), has appointed WKC Group CC (WKC) to undertake an Air Quality Impact Assessment (AQIA), required for preparation of the Environmental and Social Impact Assessment (ESIA), for the proposed Jindal Melmoth Iron Ore Project (hereafter referred to as the "Project"). The ESIA process will be conducted in line with both the National Requirements, and the International Finance Corporation (IFC) and World Bank Group requirements and guidelines. The Project site is located 25 kilometres (km) southeast of Melmoth, within the Mthonjaneni Local Municipality in the KwaZulu-Natal (KZN) Province.

Jindal Iron Ore (Pty) Ltd (Jindal), is owned by Jindal Steel and Power (Mauritius) Limited (74%) and South African partner Mr. Thabang Khomo (Pty) Ltd (26%). Jindal holds two Prospecting Rights over the Project site. The prospecting rights are referred to as North Block (PR 10644) and South Block (PR 10652), with areas of 8,467 hectares (ha) and 11,703 ha, respectively.

This study details the assessments carried out in the south-eastern section of the South Block. The south block lies on the south side of Melmoth with Nkandla Municipality to the southwest and uMlalazi Municipality to the southeast.

Table 1-1 provides the Project identification details.

Table 1-1 – Project Information

Facility Identification	Jindal Melmoth Iron Ore Mine
Ownership	Jindal Iron Ore (Pty) Ltd
Property Description	Rural Residential/Subsistence Farms
Physical Address	North Block: • Reserve No.11 15831 (Ptn 3, 4); and, • Ntembeni 16921. South Block: • Kromdraai 6110; • Black Eyes 13385 (Ptn 1, 2, 3, 4, RE); • Wilderness 6107 (Ptn 3, 4, 5, 6, 7, 8,12, 13, 14, 15, 16); • Goedgeloof 6106 (Ptn 1, 2, 3, RE); • Goedertrow 89 No. 7806; • Reserve No.11 15831; and,

	• Vergelegen 6104.
Province	KZN
Approximate Coordinates from Site Centre Point	Universal Transverse Mercator (UTM) Co-ordinates: 350,365 m E 6,822,649 m S
Elevation above Mean Sea Level	740 meters (m)
Project Footprint	11,703 ha
Municipality	Mthonjaneni Local Muncipality

1.2 Project Background

In 2013 Jindal appointed Golder Associates Africa (Pty) Ltd. (Golder) as the independent Environmental Assessment Practitioner (EAP) responsible for managing the ESIA and the supporting Public Participation (PP) process. Golder submitted a Final Scoping Report to the Department of Economic Development, Tourism and Environmental Affairs (DMR EDTEA) under both Jindal Iron Ore (for the mining ESIA) and Jindal Processing KZN (for the Processing Plant ESIA) in March 2015.

In June 2015 both Scoping Reports (mining and processing) were returned to Jindal with comments from the EDTEA requesting more clarity on various aspects of the Project, company structure and further engagement with Interested and Affected Parties (I&APs).

In the interim the iron ore price declined from a high of $130 per tonne in January 2014 to a low of $47 per tonne in December 2015. The decline in the iron ore and steel prices worldwide resulted in reduced funding from Jindal for the Project and it was not possible to complete an amended Scoping Report.

In 2019 through 2020 the iron ore price steadily recovered and the first quarter of 2021 averaged $160 per tonne. The improved iron ore price has encouraged Jindal to increase the rate of development of the Melmoth Iron Ore Project.

In January 2021 Jindal appointed SLR Consulting South Africa as the independent EAP to undertake a new ESIA and public participation process and prepare all documentation for a Mining Right Application (MRA). In March 2021, WKC was appointed to undertake the air quality specialist study. This section details the Project activities, the study objectives, and the scope of the modelling study.

1.2.1 Study Objectives

The key objective of this study was to evaluate the significance of potential impacts to ambient air quality associated with the operational phase mining activities, through the use of an air dispersion modelling study. This report focuses on the Project activities that were explicitly modelled for impact assessment purposes (i.e., a conservative worst case future operational year). Other Project phases or activities that may have an impact on ambient air quality that were not modelled due to the scale of uncertainty (for example construction phase, decommissioning phase and blasting activities), are assessed qualitatively within the ESIA. In addition, given the nature and scale of the mining activities, the assessment focuses on fine particulate matter (PM_{10} and $PM_{2.5}$) and nuisance dust. Experience of assessing the exhaust emissions from on-site plant and site traffic suggests that they are unlikely to make a significant impact on local air quality [1] and therefore a quantitative assessment of non-road mobile machinery has been screened out. In addition, the Project tailings facility has been established and will be part of a separate study..

In order to predict the possible impacts from the proposed mine operations on the surrounding environment, the following was undertaken:

- A review of relevant national ambient air quality legislation and the provision of a summary of the minimum standards that will need to be achieved in ambient air;
- A review of existing baseline air quality within the Project area;
- Quantification of key emission sources; and,
- A quantitative assessment of the operational phase activities with specific reference to the regulated criteria pollutants using the United States Environmental Protection Agency (US EPA) approved AERMOD regulatory model.

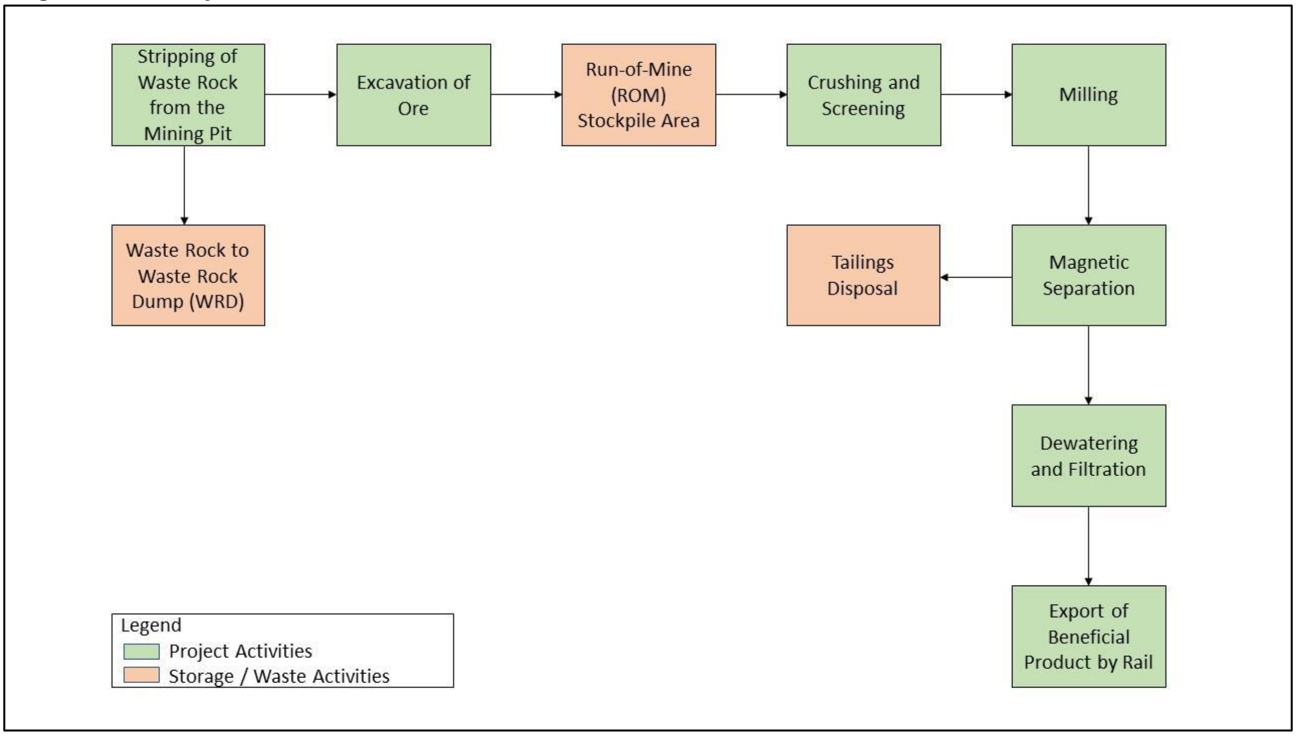
The following pollutants have been assessed due to their known impact on human health and the environment and their potential to be released to the atmosphere from Project activities

- PM: PM_{10} and $PM_{2.5}$ (fine particulate matter with an aerodynamic diameter of less than 10 and 2.5 micrometres respectively) pose a health risk as the particles can penetrate deep into the lungs and may even enter into the bloodstream. Exposure to such particles can affect both the lungs and heart; and,
- Dust and dust fall (deposition of dust), which usually constitutes a nuisance to those exposed and may impact on agricultural activities.

1.2.2 Project Activities

The following activities pertains to the south-eastern section of the South Block, termed the 'Southeast Pit'. Mining activities will take the form of open pit mining wherein approximately 800 million tonnes of ore are anticipated to be mined from the Southeast pit over a period of approximately 25 years. A broad outline of the Project activities is shown below.

Figure 1-1– Project Activities



Activities can be summarized as follows:

- Stripping of the waste rock from the pit will occur at a ratio of approximately 0.5 tonnes of waste rock per 1 tonne of ore;
- Thereafter, the waste rock will be disposed of at a predetermined Waste Rock Dump (WRD) location within the Mining Right Area;
- Excavation of iron ore will be accomplished via drilling and blasting techniques;
- The excavated iron ore will then be loaded onto trucks and transported to the Run-of-Mine (ROM) ore stockpile area where it will be stored and subsequently transferred to the primary crusher before being transferred to the processing plant for milling and magnetic separation; and,
- The processing plant will produce iron ore concentrate (approximately 7.5 million tonnes per annum (mtpa) consisting of 67% iron (Fe)) and a tailings slurry wherein the former will be exported to local markets and the latter will be disposed of to a tailings storage facility (TSF).

Associated infrastructure to support the mine will include access and haul roads, electrical transmission line and sub-stations, raw water abstraction and pipelines, stormwater management infrastructure, tailings pipelines, concentrate pipelines, offices, change house, workshops and perimeter fencing (amongst others).

Some of the infrastructure required for the mine (e.g., the access road, pipelines and TSF) may be located outside of the MRA. While the access road and water supply pipelines are part of this application to the Department of Mineral Resources and Energy (DMRE), certain other infrastructure (for example tailings disposal) will be subject to separate application, assessment and approval processes, as required by the applicable legislation.

Additional detail is provided in the following sections on the major infrastructure, where information is available.

Waste Rock Dump

Waste rock dumps are required to accommodate overburden and waste rock excavated as part of the mining process. The waste rock dump would be designed to fit into the existing contours to the extent practical for stability and ultimate closure rehabilitation.

Primary Crusher

ROM ore will be transported via haul truck to a semi-mobile in pit primary crusher. Primary crushed ore will be transported from the in pit primary crusher to the ROM stockpile via overland conveyor. ROM ore will be reclaimed from the ROM stockpile for further crushing before being deposited onto the crushed ore stockpile.

Processing Plant

Ore from the crushed ore stockpile will be fed into the processing plant. It is anticipated that the proposed processing plant would be designed to process 32 mtpa of iron ore. Iron ore will be processed using crushing, milling and magnetic separation techniques. The plant will produce wet iron ore concentrate (upgraded from 30% Fe in feed to 67% Fe in concentrate) which will be thickened and filtered to remove water which is recycled within the process. Approximately 7.5 mtpa of iron ore concentrate would be transported 80 km to the Richards Bay Port by rail using the Nkwalini rail siding situated 4 km from the Project site.

In addition to the iron ore concentrate, the plant will also produce thickened wet tailings slurry which will be deposited in a TSF.

The following standard activities are proposed as part the processing operations:

- Crushing and Screening;
- High Pressure Grinding Roll (HPGR) and ball/pebble milling;
- Magnetic separation and concentrate re-grind;
- Tailings disposal;
- Concentrate Dewatering and Filtration; and,
- Transport, storage and shipment of final beneficiated product.

Water Infrastructure

The mining operations will require water for the processing plant, dust control, for vehicle wash down and for the change house and office use. The conceptual design is for water to be recycled from the TSF and the concentrate filters thereby minimising daily water usage. There will be a need for make-up water to replace water losses from seepage, evaporation and interstitial. It is anticipated that the make-up water would be acquired from the KZN bulk water supply authority. However, a water supply analysis will be undertaken as part of this Project which will determine water demand and where water would come from. Water requirements are likely to reduce as the pit deepens due to the reuse of water that collects within the pit.

In addition, water management infrastructure will be required including dirty water dams, pollution control dams and storm water management. The location and design of these will be identified as the Project progresses.

Office Complex

An office complex is required to accommodate all management, technical, and administration staff for the mine. The office complex will include a car park, canteen, meeting rooms, hall, training complex, security and first aid station. The site will have a dedicated sewerage treatment plant the detail of which is to be considered as part of the BFS.

Workshops

Engineering and vehicle workshops, tyre shops, wash down areas, garages, fuel depots and explosive magazines will be located at the centre of the activity that the facility services for ease of access. The detail will be considered as part of the BFS.

Access Road

Further studies will be undertaken during the BFS, and enquiries with landowners about potential route planning, to identify possible access routes for the transport of labour, equipment and materials to the Project site during the construction phase and for other activities during the operational, decommissioning and closure phases.

Power Supply

Existing 400 kilovolt (kV) transmission lines owned by Eskom run through the South Block to a point approximately 700 m from the envisioned main plant intake substation. The lines are relatively new and have adequate installed capacity for the mine requirements. Connecting distribution lines and a substation will be required for the mining operations. This would likely be adjacent to the processing plant.

Possible Future Phases

Prospecting, including drilling programmes, will be undertaken in parallel with the Phase 1 mining. This would generate additional information on the iron ore resource in the North and balance of the South block and will be used to inform planning of possible future mining phases. Any future development phases of the Melmoth Iron Ore Project would need to be subject to the requisite regulatory application, assessment, and approval processes.

1.3 Project Location

1.3.1 Site Layout

The Project site is located 25 km southeast of Melmoth, within the Mthonjaneni Local Municipality and the King Cetshwayo District Municipality in the KZN province.

1.3.2 Area Maps

The Project location in the context of its local and regional setting is illustrated in Figure 1-2 and Figure 1-3, respectively.

Figure 1-2 – Project Location (Regional Context)

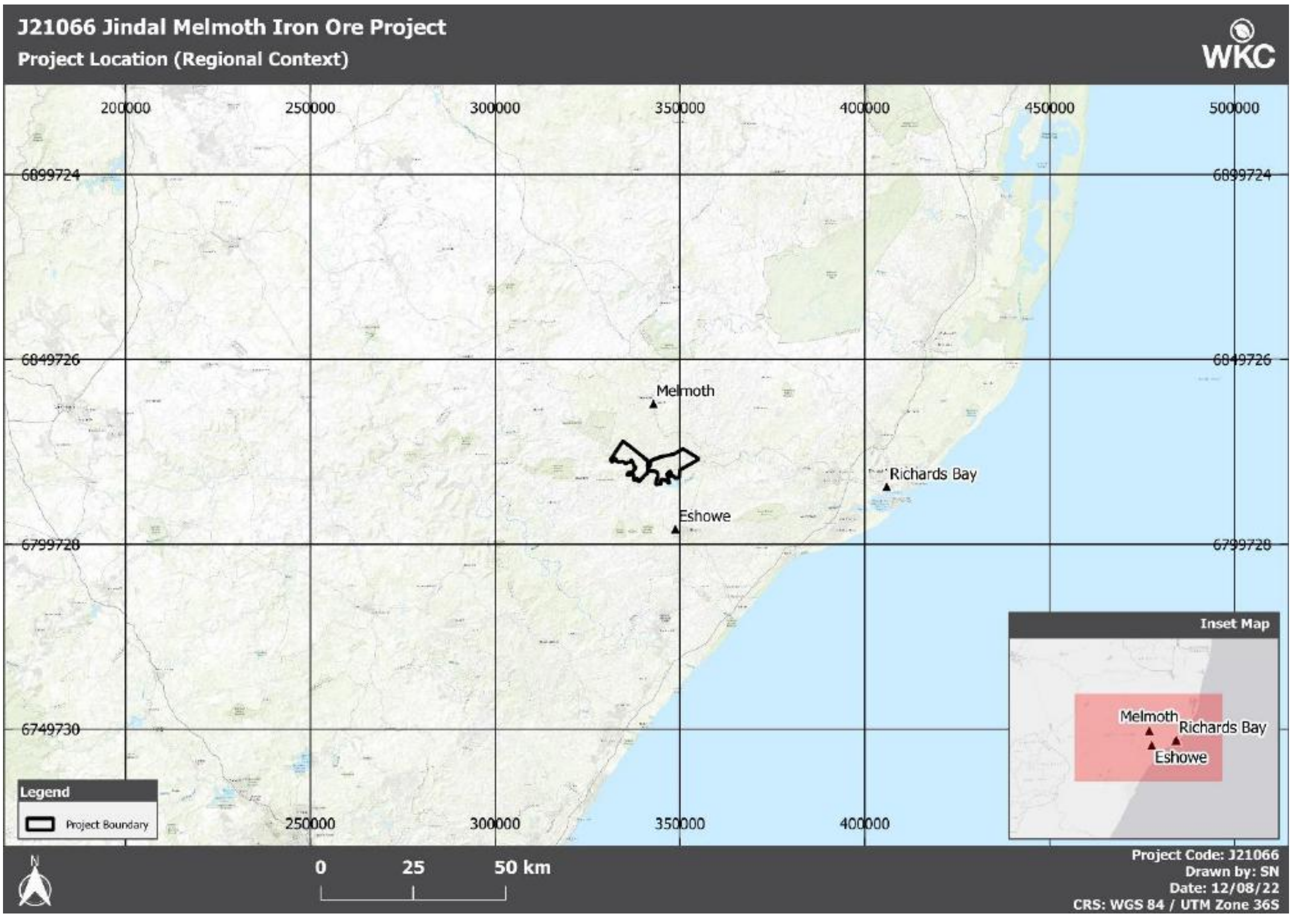
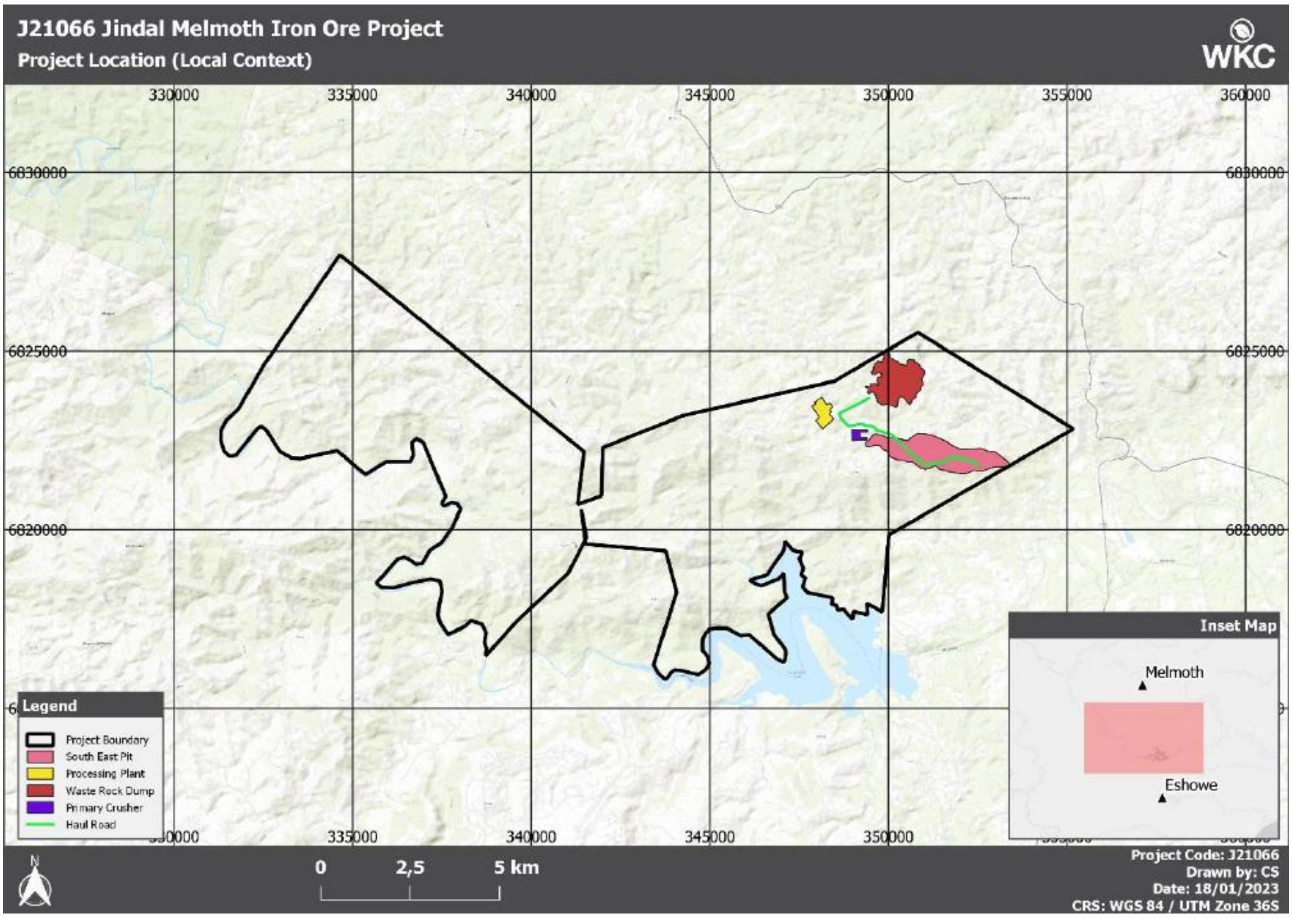


Figure 1-3 – Project Location (Local Context)



1.4 Geophysical Data

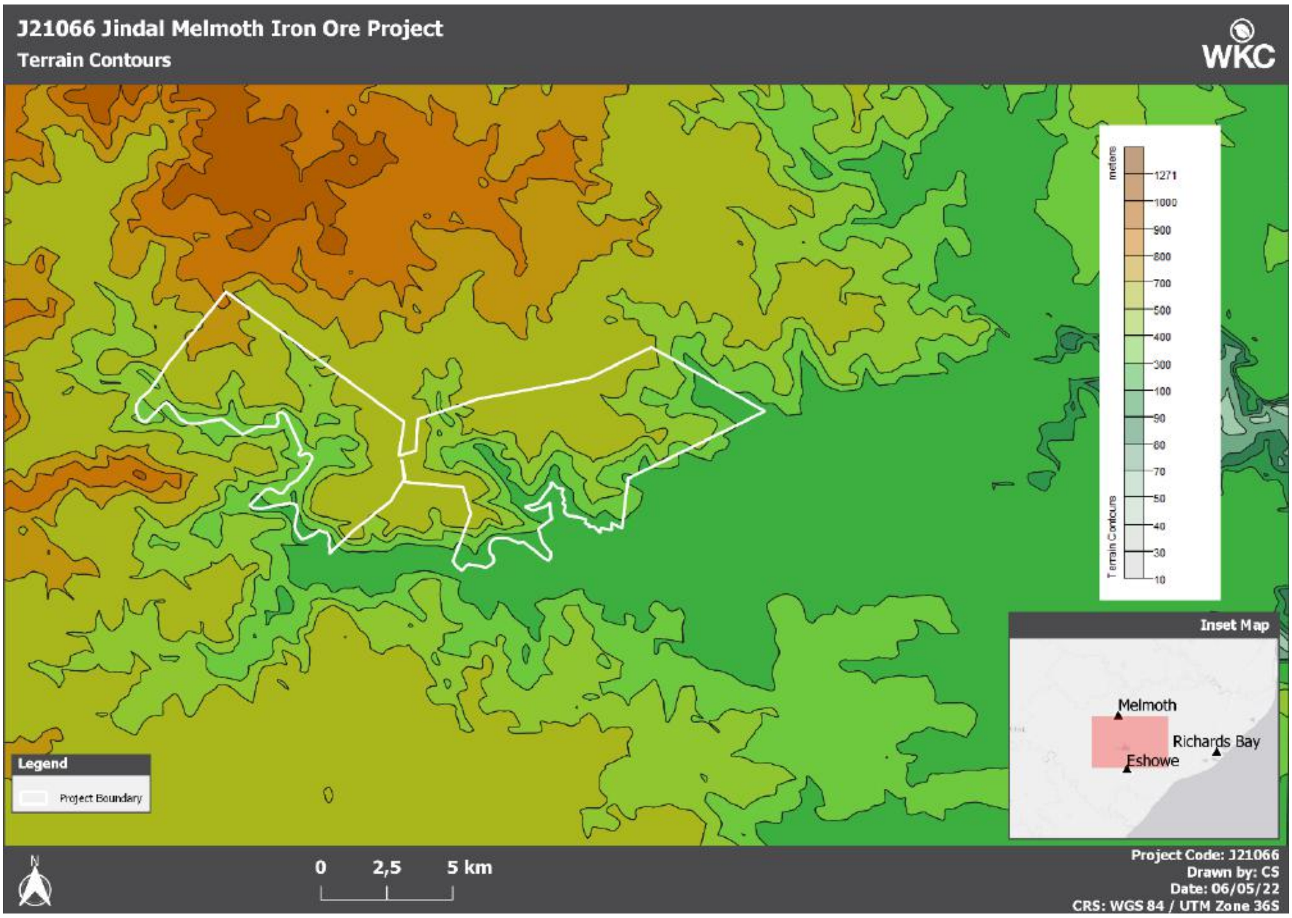
1.4.1 Land Use

The immediate area is largely characterised by grasslands, natural vegetation cover, subsistence farming, forestry, rural settlements and cultivated commercial crops. The land use classification within the model domain was distinguished using the Auer method, as specified in the Code of Practice [2]. In accordance with this method, the immediate vicinity of the Project site (within a radius of three km) is classified as agricultural rural. This is due to the area having >35% vegetation coverage.

1.5 Elevation Data (DEM) and Resolution

Shuttle Radar Topography Mission (SRTM) 1 Global terrain data was included in the model. The terrain data resolution is 30 m, and it was imported via the Lakes AERMOD View, WebGIS interface. A terrain contour is presented in Figure 1-4.

Figure 1-4 – Terrain Contours



2 Emissions Characterisation

2.1 Operations Phase

2.1.1 Emission Characteristics

Once the plant becomes operational the key emission sources consist of:

- The excavation of overburden through blasting and excavators / front-loaders;
- Hauling of overburden to the WRD;
- The excavation of ROM material through excavators / front-loaders;
- Stockpiling of ROM;
- Crushing of ROM;
- Conveying of ROM to the processing plant;
- Wheel-entrained dust from vehicles travel along site roads; and,
- Wind blown emissions from the above sources.

2.1.2 Operating Scenarios for Emission Units

A single scenario representing the year with the largest mining throughput (Year 22) was considered as a reasonable worst-case representation of the mining activities, considering PM_{10} and $PM_{2.5}$ as well as the deposition of Total Suspended Particles (TSP). As there are no significant stationary combustion sources or secondary processing activities on site (i.e., direct reduced iron production / smelting) there are no start-up, shutdown, or standby scenarios applicable to the assessment.

2.1.3 Proposed Emissions and Source Parameter Tables

An emissions inventory has been compiled to determine the pollutant emissions from all significant fugitive dust sources associated with the future mining operations.

2.1.3.1 Fugitive Sources

Fugitive dust and emissions of PM_{10} emanate from material handling activities. In order to quantify fugitive emissions for this assessment, default emission factors for various operations were sourced from the US EPA AP 42 [4] as well as National Pollution Inventory (NPI) Emissions Estimation Technique Manual [6]. These emission factors were used in the absence of locally developed emission factors. The Project owner has committed to the following design mitigation measures, which were accounted for when developing the emission inventory (where applicable).

Table 2-1 – Mitigation Considered as Part of the Project Design Basis

Project Area	Mitigation
General	• Focused staff training on air quality management; and, • Detailed equipment maintenance and preventative maintenance schedules in place focused on dust minimisation.
Working Areas	• Water spraying on all unpaved roads for dust control; • Restricted vehicle speeds; and, • Minimised idling of vehicles.
Waste Rock Dump	• Water sprays during dumping activities; and, • Active WRD management through controlled placement of material and design of WRD.
Crusher	• Ore tipped directly into the crusher with fogger at the transfer point; and, • Hooded conveyors from the crusher to the processing plant.
Processing Plant	• Enclosed processing plant; • Water sprays at tipping points of the conveyor to the stockpile; and, • Ore will be kept wet.
Haul and access roads	• Water and chemical sprays will be used for dust suppression on haul roads.

The emission rates estimated for each of the activities at the future mining pit area are detailed in Table 2-2, which includes the abatement measures outlined.

Table 2-2 – Fugitive Emissions Inventory

Process	Activity / Source	Total Emissions (TPA)			Design Mitigation Control Efficiency
		TSP	PM_{10}	$PM_{2.5}$	
Waste Rock Removal	Excavators / shovels / front-end loaders on waste rock	400	192	57.62	
	Handling, transferring and conveying	80.10	32.00	9.60	
	Wheel generated dust from unpaved roads (to waste rock dump)	7,931	525	157	75% for level 2 watering (< 2 litre/m^2/hour)
	Truck (loading waste rock)	80.10	31.85	9.56	
	Truck (dumping waste rock)	95.87	34.37	10.31	50% for watering / sprays
	Movements on waste rock at waste rock dump	400	192	57.62	

Process	Activity / Source	Total Emissions (TPA)			Design Mitigation Control Efficiency
		TSP	PM_{10}	$PM_{2.5}$	
	Wind erosion from overburden dumps	1,104	388	166	
ROM Handling	Loading ROM from pit	80.10	32.00	9.60	
	Wheel generated dust from unpaved roads	7,931	525	157	75% for level 2 watering (< 2 litre/m^2/hour)
	Loading stockpiles	40.05	16.08	4.83	50% for watering / sprays
	Wind erosion from ROM stockpiles	15.94	2.54	0.76	50% for watering / sprays
	Unloading from stockpiles	240	104	31.22	50% for watering / sprays
	Transfer of ROM to crusher	288	144	43.24	70% for enclosure
Crushing	Crushing of ROM	160	64.02	19.21	
	Transfer of crushed ore to conveyor	80.10	14.38	4.31	70% for enclosure
Low Grade Ore Stockpile	Loading stockpiles	3.15	1.26	0.38	50% for watering / sprays
	Movements on low grade ore at stockpile	29.96	14.51	4.35	
	Unloading from stockpiles	17.98	7.88	2.37	50% for watering / sprays
	Wind erosion from low grade ore stockpiles	5.23	2.61	0.78	50% for watering / sprays
Primary Crushed Ore	Loading stockpiles	39.74	16.08	4.83	50% for watering / sprays
	Movements on primary crushed ore at stockpile	400	192	57.62	
	Unloading from stockpiles	240	104	31.22	50% for watering / sprays
	Wind erosion from primary crushed ore stockpiles	5.05	2.52	0.76	50% for watering / sprays
	Conveying of crushed ore to process plant	24.00	9.60	3.2	70% for enclosure
Access Road	Wheel generated dust from unpaved roads	103	27.50	2.75	75% for level 2 watering (< 2 litre/m^2/hour)
Blasting	Blasting	5.79	3.07	0.17	
Total:		**19,800**	**2,678**	**846**	

a: See Appendix C for Haul Route Calculations

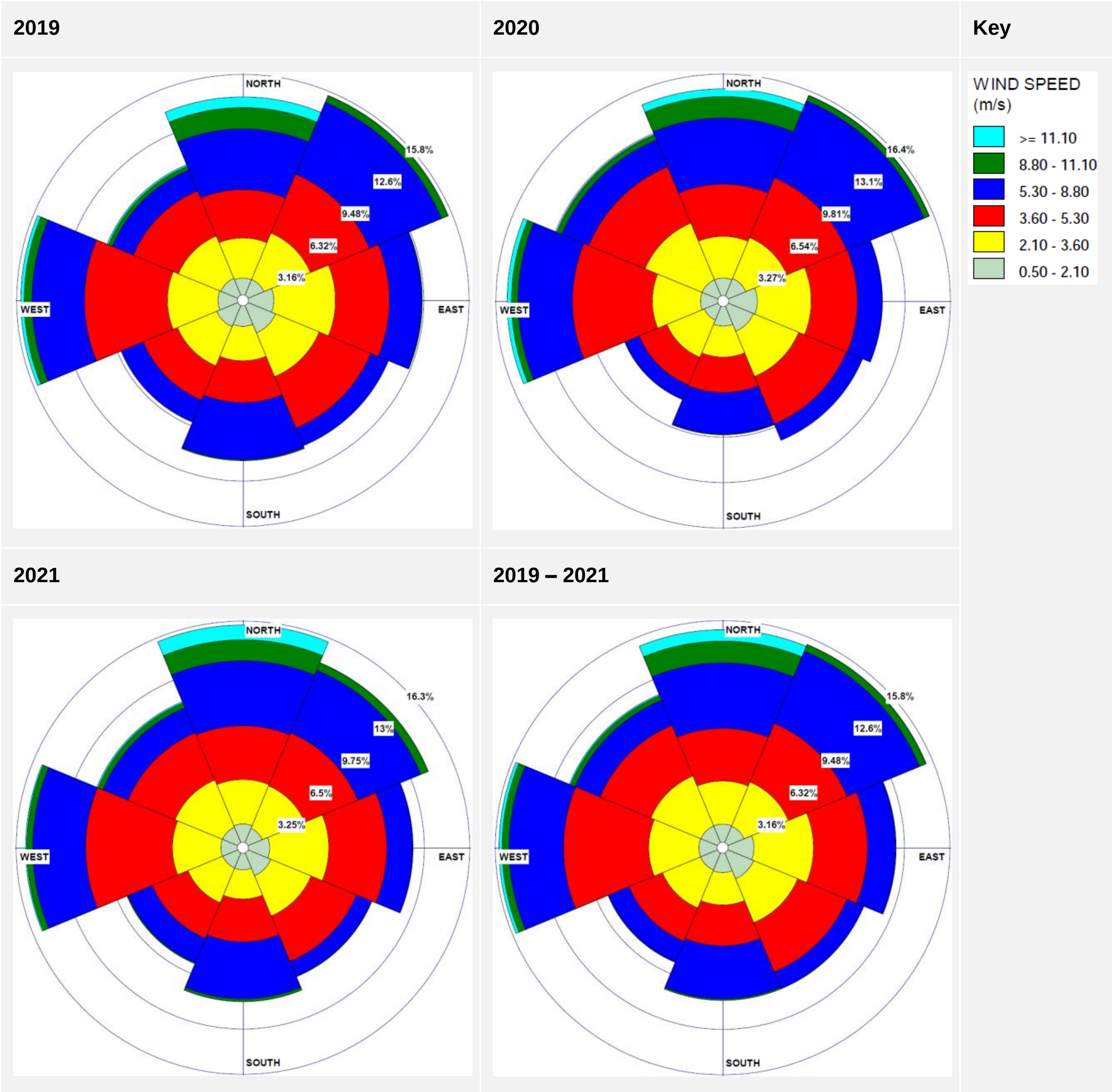
3 Meteorological Data

Local meteorological conditions affect the plume dispersion of emissions with plumes being largely transported in the direction of the wind. Atmospheric stability criteria influence both plume fall-out and the resulting pattern of dispersion. There is a preference to use meteorological data for dispersion modelling that has been collected as close as possible to the Project site; however, the meteorological measurements should be inclusive of the various parameters necessary for incorporation into the model and be suitably quality assured. Three years (2019 to 2021) of site-specific Weather Research and Forecasting (WRF) meteorological data (both surface and upper air files) were obtained from, Lakes Environmental, a reputable meteorological data service provider.

3.1 Annual Wind Roses

Wind roses were obtained from meteorological data mentioned above for the years 2019 to 2021 and are presented in Figure 3-1. An analysis of the wind roses indicates that for the period 2019 to 2021 the prevailing wind direction is west and north easterly directions. There is a high occurrence of low to medium winds (speeds less than 8.8 m/s) and a lower frequency emerged from the south westerly direction.

Figure 3-1 – Meteorological Wind Roses

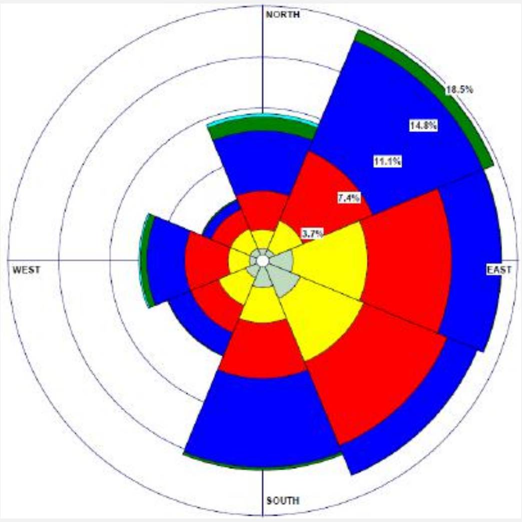
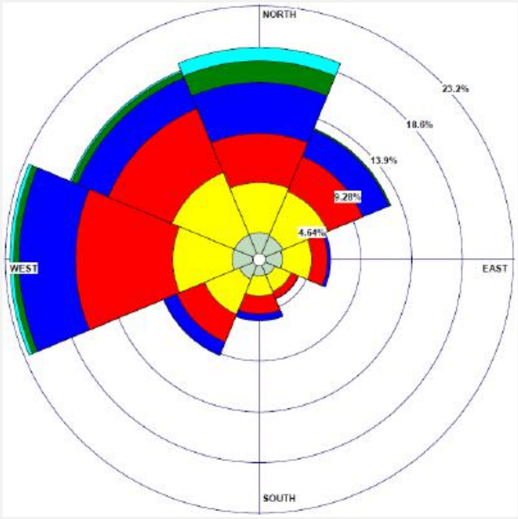
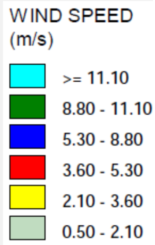


3.2 Day Night Wind Roses

Wind roses were obtained from meteorological data mentioned above for the years 2019 to 2021 and are presented in Figure 3-2. The day-time wind rose plot illustrates winds predominantly propagating in the north easterly direction with considerable wind emanating from the southerly and easterly region. Wind speeds within the ranges of 5.30 – 8.80 m/s and 8.80 – 11.10 m/s each occur approximately 19% of the time during the day.

At night, wind propagates predominantly from the westerly direction with considerable winds originating from the north and north westerly regions. Wind speeds within the ranges of 5.30 – 8.80 m/s, 8.80 – 11.10 m/s and >= 11.10 m/s each occur approximately 23% of the time during the night.

Figure 3-2 – Meteorological Wind Roses: Day Night Wind Roses

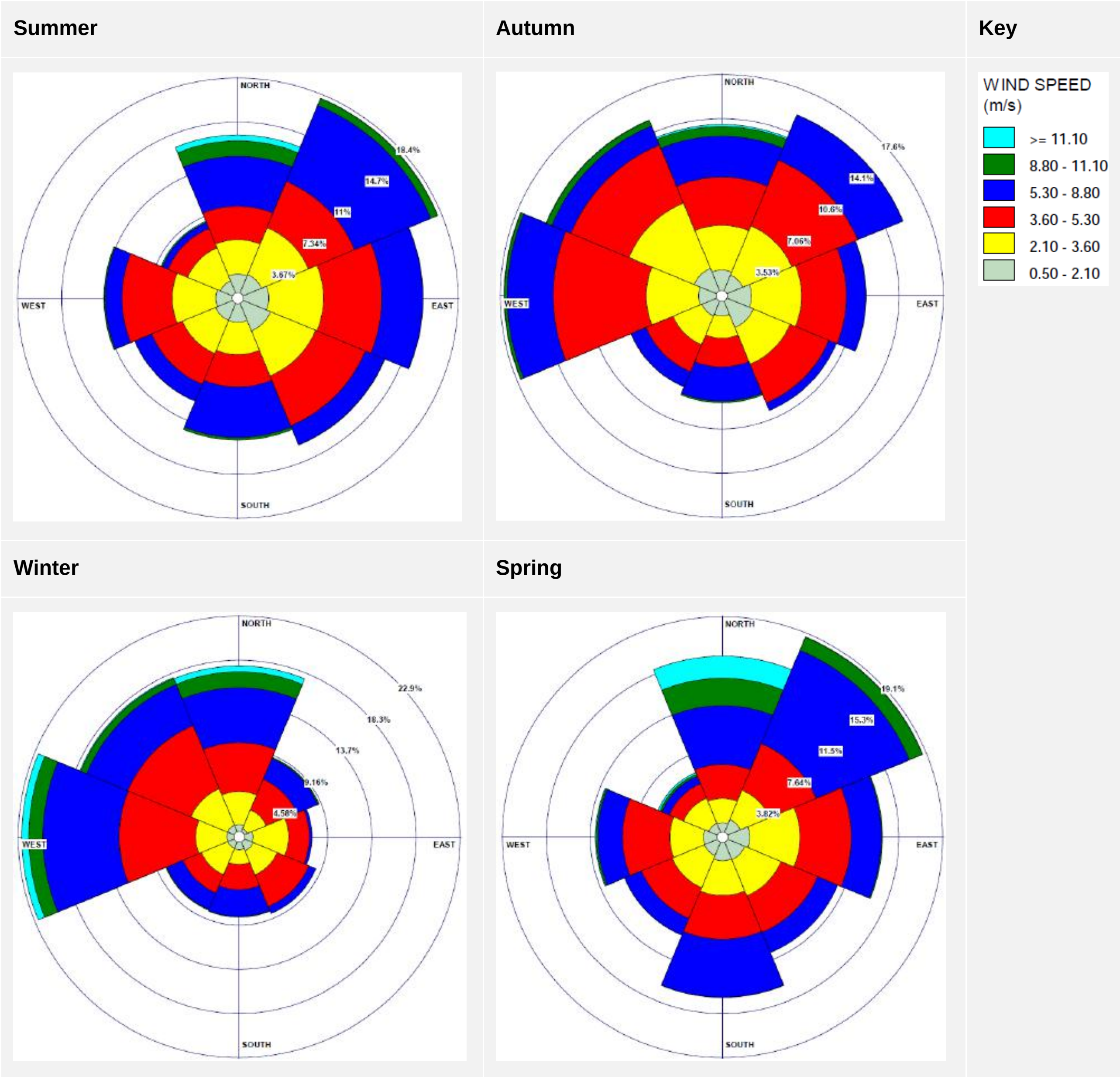
Day	Night	Key
		

3.3 Seasonal Wind Roses

Wind roses were obtained from meteorological data mentioned above for the years 2019 to 2021 and are presented in Figure 3-3. The wind speed and direction are influenced by variations in the climate conditions during different seasons of the year. The spring and summer wind rose plots illustrates wind predominantly originating from the north easterly region with considerable wind emanating from the northern, eastern, and southern direction. In spring and summer, wind speeds within the ranges of 5.30 – 8.80 m/s and 8.80 – 11.10 m/s each occur approximately 18% and 19% of the time, respectively.

In winter and autumn, winds predominantly propagate from the westerly region with considerable wind originating from the northern direction in winter and, the northern and north easterly direction in Autumn. In winter, wind speeds within the ranges of 5.30 – 8.80 m/s and 8.80 – 11.10 m/s occur approximately 20% and 23% of the time, respectively. In autumn, wind speeds within the ranges of 5.30 – 8.80 m/s and 8.80 – 11.10 m/s occur approximately 18% of the time.

Figure 3-3 – Meteorological Wind Roses: Seasonal Wind Roses



4 Ambient Impact Analysis and Ambient Levels

4.1 National Ambient Air Quality Standards

Under the National Environmental Management (NEM): Air Quality Act (AQA) (Act No.39 of 2004) [3], National Ambient Air Quality Standards (NAAQS) have been set with the aim of reducing harmful effects on human health and / or the environment. In line with the World Health Organisation's (WHO's) position, the primary aim of Ambient Air Quality Standards (AAQS) is to provide a uniform basis for the protection of public health and ecosystems from the adverse effects of air pollution, and to eliminate or reduce to a minimum, exposure to those pollutants that are known or likely to be hazardous. The relevant standards are presented in Table 4-1 below.

Table 4-1 – South African NAAQS Relevant to the Project

Pollutant	Averaging Period	NAAQS Concentration (μg/m³)[1]	NAAQS Permitted Frequency of Exceedance
PM_{10}	24 Hours	75	4
	1 Year	40	0
$PM_{2.5}$	24 Hours	25	4
	1 Year	15	0
Notes:			
[1] μg/m³ – microgram per cubic metre			

The NAAQS also include national dust control regulations [4] used to assess the deposition of dust caused by Project activities. The dust fallout rates applicable to this Project are presented in Table 4-2.

Table 4-2 – Standards for Acceptable Dust fall-out Rates

Restriction Area	Dust Fallout Rate (D) (mg/m²/day, 30-day average)	Permitted Frequency of Exceeding Dust Fallout Rate
Residential Area	D < 600	Two within a year, not sequential months.
Non-residential Area	600 < D < 1200	Two within a year, not sequential months.

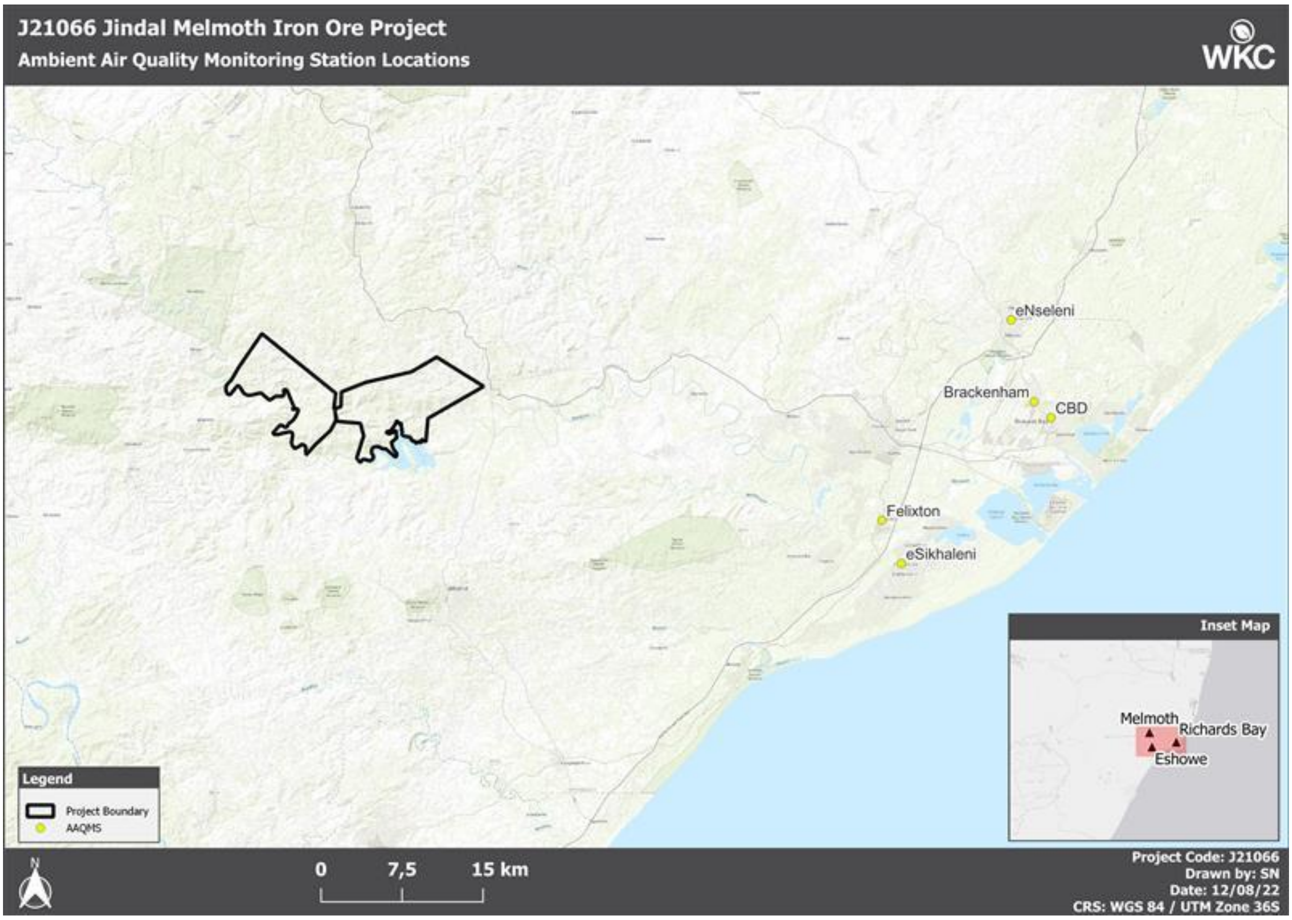
4.2 Background Concentrations

This section describes the current environment in terms of publicly available ambient air quality data acquired from the South African Air Quality Information System (SAAQIS), collected by the Richards Bay Clean Air Association (RBCAA), as well as the site-specific monitored PM and dust-fall data collected at the site.

4.2.1 Regional Air Quality Data

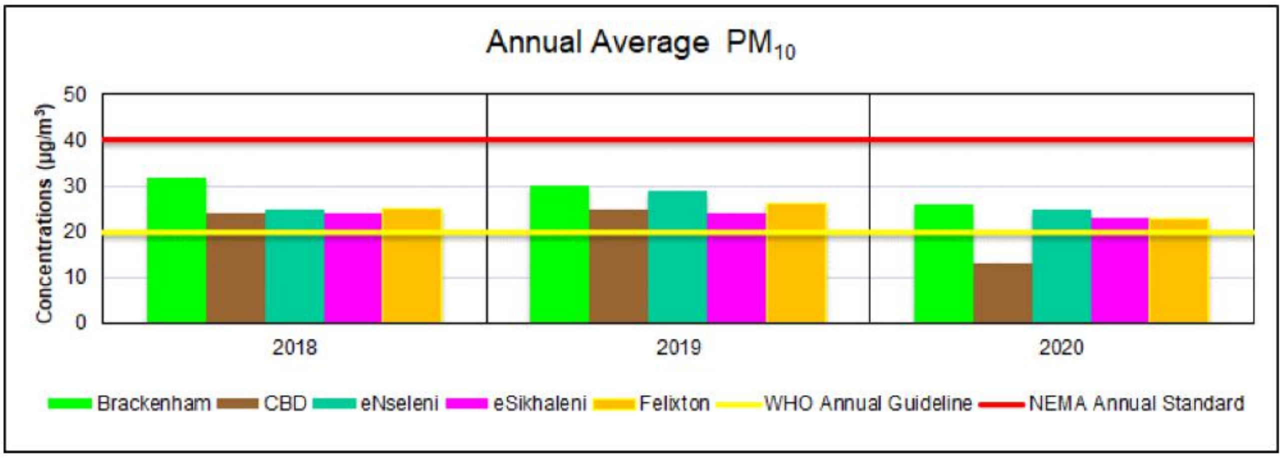
The Code of Practice [5] states that the background concentrations can be obtained from a network of long-term ambient monitoring stations near the source under study, or long-term ambient monitoring at a different location that is adequately representative. The nearest ambient air quality stations with representative data are located approximately 40 km – 60 km from the Project site in Felixton, eSikhaleni, Brackenham, eNseleni and Richards Bay Central Business District (CBD). The locations of the stations are presented in Figure 4-1. As shown in Figure 4-2 data sets for the period analysed are not complete for each individual site, however, trends across all five sites are similar.

Figure 4-1 – Ambient Air Quality Monitoring Stations



In order to establish a long term baseline average, the annual PM_{10} concentration averages measured at the five stations were analysed and are presented Figure 4-2. Based on the available graphical data, the average annual PM_{10} concentration across all five stations has been estimated to be approximately 24.40 µg/m^3, which is below the NAAQS for the periods considered. The limitation of the public network data is that no $PM_{2.5}$ data is available at the selected ambient air quality monitoring stations.

Figure 4-2 – PM_{10} Annual Averages [6]



It should be noted that the Richards Bay area hosts a number of large industries and mining activities, therefore, the background PM_{10} concentrations are likely to be higher than for the inland rural areas.

4.2.2 Ambient Air Quality within the Project Area

The following sources and activities contribute to the baseline pollutant concentrations within the immediate Project area:

- Agricultural activities: majority of the commercial farms in the region produce sugarcane, timber and citrus. Land clearing and ploughing in preparation of fields for sowing can generate a significant amount of dust, in addition to agricultural vehicle movements. Seasonal sugarcane burning results in products of combustion, with pollutants of concern including PM as well as carbon monoxide (CO) and nitrogen dioxide (NO_2) emissions;

- Biomass burning: biomass burning is considered as the incomplete combustion of natural plant matter with PM, CO, and NO_2 being emitted during the process. Crop residue burning and wildfires represent significant sources of combustion-related emissions associated with agricultural areas;

- Domestic fuel burning: the rural households within the vicinity of the site are anticipated to rely on wood burning for space heating and cooking purposes. Emissions from these activities are expected to have an impact on air quality. More so during the winter months due to the increased demand for space heating;

- Unpaved roads and exposed areas: the quantity of dust emissions from unpaved roads vary based on the volume of traffic. Dust is generated by the loosened material lifted from the road surface by turbulent air currents created when the vehicle is moving. Given the rural nature of the Project site, dust generated by vehicles on unpaved roads is likely to be a source of PM, however, it is expected to be limited due to low traffic volumes. The greatest impacts are expected to be limited to the areas immediately adjacent to the roads (within 200 m); and,

- Vehicle emissions: Given the low population density residing in the region it is anticipated that vehicle exhaust emissions will be limited and therefore relatively insignificant. The nearest major road is the R34 which is located to the north and east of the Project site. The R34 is a long provincial route that connects Vryburg with Richards Bay via Kroonstad and Newcastle.

In order to further characterise the ambient air quality in the vicinity of the Project, a short-term ambient air quality monitoring campaign was undertaken as part of the EIA process as outlined in the following sections.

4.2.3 Site Specific Monitoring

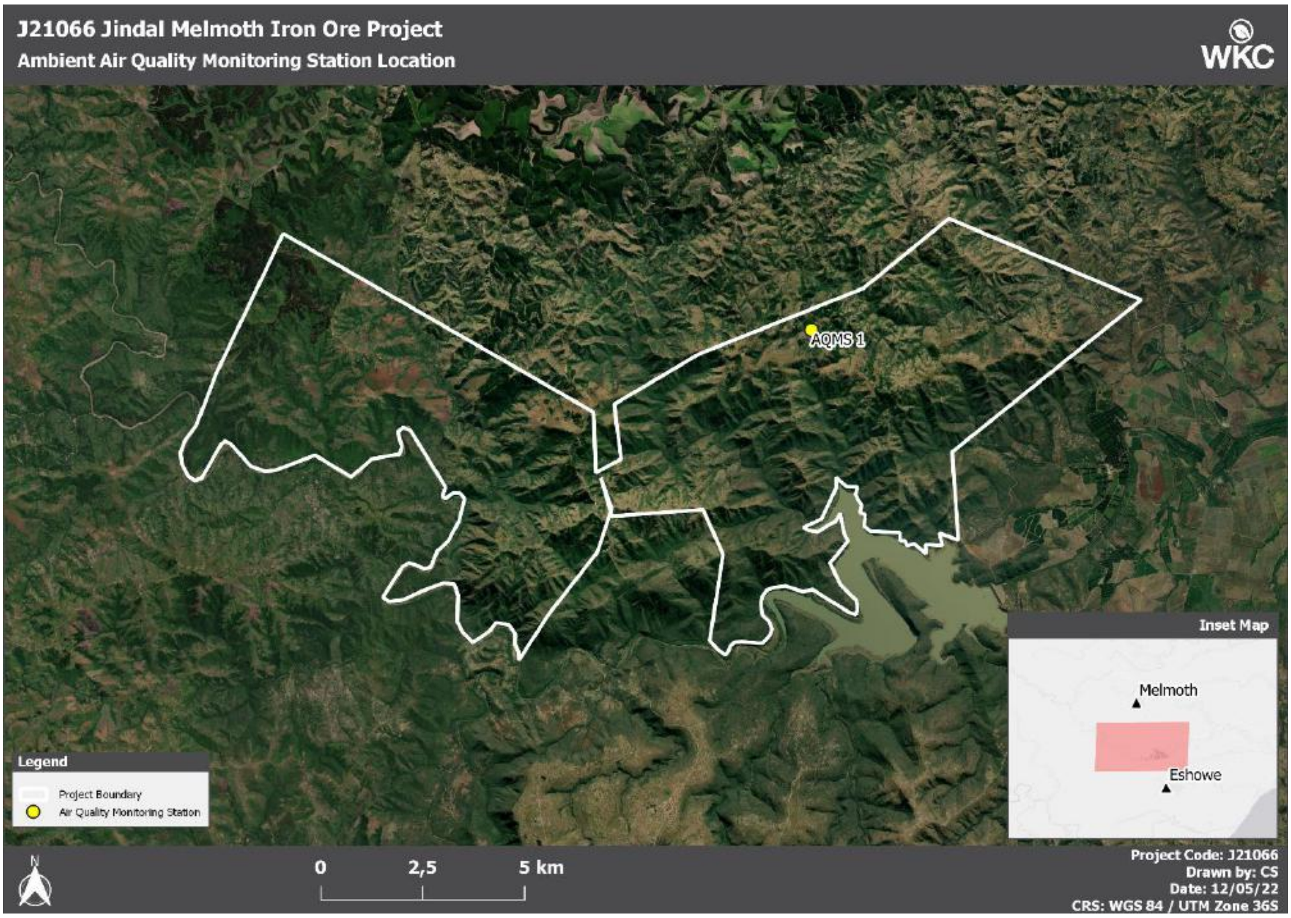
Particulate Matter Monitoring

This section details the results obtained during the real-time monitoring of PM_{10} and $PM_{2.5}$. A single Osiris Real-time Particulate Analyser (monitoring station) was set-up at the Ngobese Homestead which is located approximately 2.46 km from the Southeast Pit (Table 4-3). The instrument was deployed over a period of one month, however given the frequent power failures, a total of eight days data was collected (between 14th – 21st December 2021). The location of the Osiris Real-time Particulate Analyser is presented in Figure 4-3 and the UTM coordinates are presented in Table 4-3.

Table 4-3 – Summary of Measurement Location

Site ID	Site Description	Site Classification	UTM Coordinates	
			m E	m S
AQMS 1	Ngobese Homestead	Rural	347,071	6,823,347

Figure 4-3 – Location of Ambient Air Quality Monitoring Station



The measured 24-hour averages of PM_{10} and $PM_{2.5}$ concentrations are presented in Table 4-4 and Table 4-5, respectively. The results are also displayed graphically in Figure 4-4 and Figure 4-5 for PM_{10} and $PM_{2.5}$, respectively. Whilst the measurement period is not deemed sufficient for comparison against the national standards, it does provide a snapshot of the PM concentrations prevalent at the time. The PM_{10} concentrations ranged between 6.5 and 45 µg/m^3**,** whilst the $PM_{2.5}$ concentrations ranged between 1.5 and 12.7 µg/m^3.

Table 4-4 – PM_{10} Results for December 2021

Start Date	PM_{10} Average Concentration (µg/m³)	Wind Direction – 24 Hour Average
14/12/2021	36.2	Southerly
15/12/2021	20.2	South-south-easterly
16/12/2021	9.2	South-south-easterly
17/12/2021	44.9	South-south-easterly
18/12/2021	13.8	North-easterly
19/12/2021	10.6	West-north-westerly
20/12/2021	6.5	East-south-easterly
21/12/2021	17.4	Southerly

Table 4-5 – $PM_{2.5}$ Results for December 2021

Start Date	$PM_{2.5}$ Average Concentration (µg/m³)	Wind Direction – 24 Hour Average
14/12/2021	12.7	Southerly
15/12/2021	6.3	South-south-easterly
16/12/2021	3.7	South-south-easterly
17/12/2021	1.5	South-south-easterly
18/12/2021	3.7	North-easterly
19/12/2021	3.5	West-north-westerly
20/12/2021	2.0	East-south-easterly
21/12/2021	7.1	Southerly

Figure 4-4 – PM_{10} Daily Average Concentration

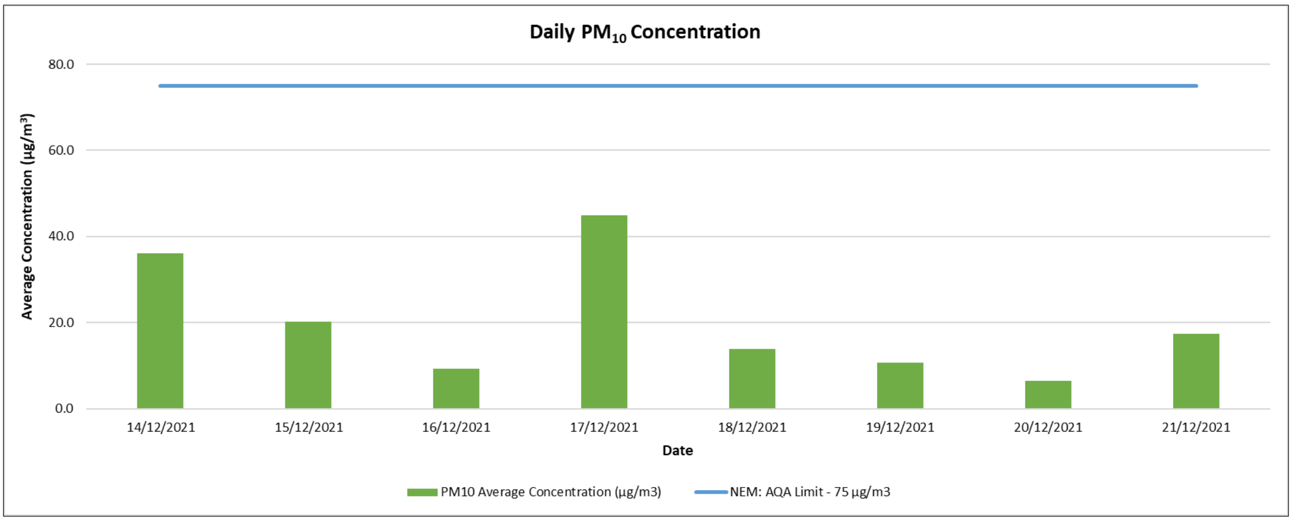
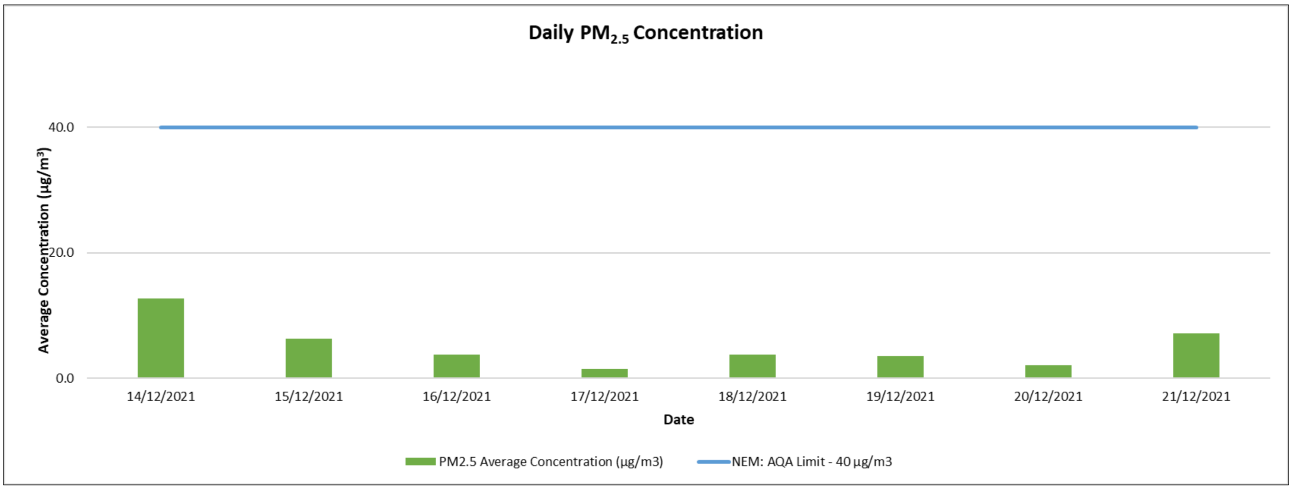


Figure 4-5 – $PM_{2.5}$ Daily Average Concentration



Due to the remote nature of the surrounding environment, the ambient air quality is considered to be reflective of a rural environment, not heavily influenced by anthropogenic background emission sources.

Dust Fallout Monitoring

Dust fallout was monitored over a 60 day period (2 x 30 day deployments in November / December / January) based on the American Society of Testing and Materials (ASTM) standard method for collection and analysis of dust fallout (ASTM D1739). A total of seven dust fallout units were deployed at the sensitive receptor locations. The method employed a simple device consisting of a cylindrical five litre (l) container, filled with 400 millilitres (ml) of de-ionized water. To prevent the growth of algae, 100 ml of copper sulphate solution was added to the reagent water. Buckets were then placed on a stand, compromising of a ring raised above the rim of the bucket, which was mounted on a long steel pole (approximately two m in height). Thereafter, the buckets were left exposed in the designated location for 30 days to collect windblown dust. As described by ASTM D1739, the 30-day monitoring period is based on the exposure period and not a calendar month.

After the appropriate exposure period, the exposed buckets were returned to environmental laboratories where the contents were gravimetrically analysed to determine the insoluble fraction (dust-fall). The following procedures were undertaken:

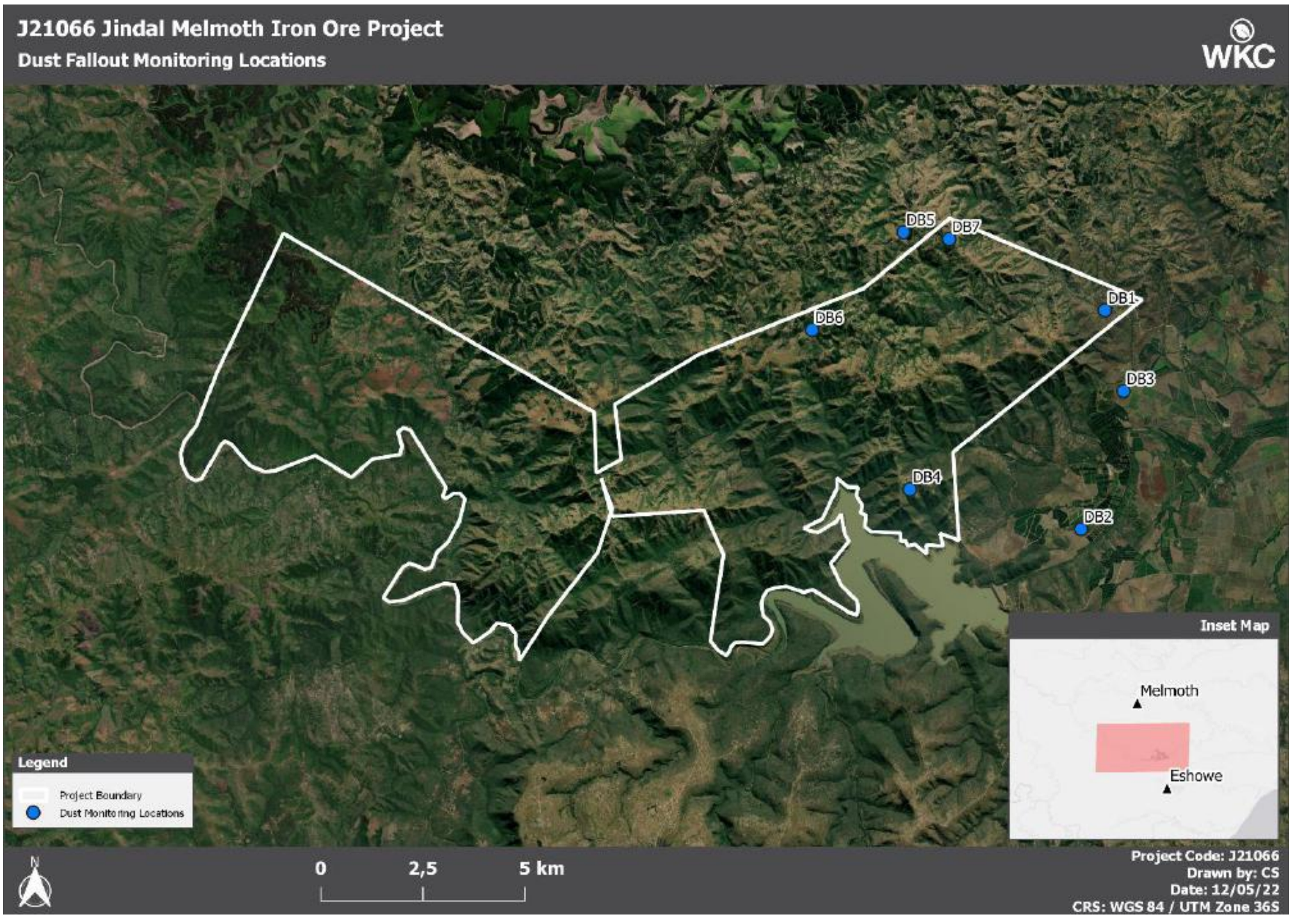
- The buckets were rinsed to remove external contaminants from any of the samples;
- The sample is filtered through a mesh course filter with a pore size of 1 millimetre (mm) to remove insects and course detritus;
- Thereafter, the sample was filtered through a pre-dried and pre-weighed filter paper that aims to remove the dust fall;
- The sides of the bucket were rinsed with deionised water and the above step of filtering was repeated until no dust remained in the bucket;
- The filter containing the accumulated dust fall was dried in an oven; and,
- Once the filter was dried, the gravimetric analysis was conducted to determine the insoluble fraction.

A total of seven locations were included near the Project area for the dust fallout monitoring. All locations are classified as residential; therefore, the applicable Dust Fallout Rate (D) standard is less than 600 milligram per square metre per day (mg/m^2/day). A summary of the monitoring locations and a satellite image of the locations is presented in Table 4-6 and Figure 4-6, respectively.

Table 4-6 – Dust Fallout Monitoring Locations

Monitoring Location ID	Location Description	UTM Coordinates		Dust Fallout Limit (mg/m^2/day, 30-day average)
		m E	m S	
DB 1	Chenells Farm – Venture Compound	354,242	6,822,707	< 600
DB 2	Chenells Farm – Hillcrest 40 Block Compound	352,830	6,817,506	< 600
DB 3	Siyavuma Primary School	354,384	6,820,681	< 600
DB 4	Ngobese Homestead	348,831	6,819,121	< 600
DB 5	Mxosheni Combined School	349,657	6,825,365	< 600
DB 6	Nogajuka Primary School	347,071	6,823,350	< 600
DB 7	Mehlamasha Combined School	350,738	6,825,025	< 600

Figure 4-6 – Dust Fallout Monitoring Locations



A summary of the possible dust sources at each monitoring location is provided in Table 4-7.

Table 4-7 – Possible Sources of Dust at Each Dust Monitoring Location

Monitoring Location ID	Location Description	Possible Dust Source[1]
DB 1	Chenells Farm – Venture Compound	• Re-entrained vehicle dust from external unpaved roadways; • Farm operations; and, • Natural dust (naturally eroded quartz, topsoil, agricultural soil).
DB 2	Chenells Farm – Hillcrest 40 Block Compound	
DB 3	Siyavuma Primary School	• Re-entrained vehicle dust from external unpaved roadways; • Construction material; and, • Natural dust (naturally eroded quartz, topsoil, agricultural soil).
DB 4	Ngobese Homestead	
DB 5	Mxosheni Combined School	• Re-entrained vehicle dust from external unpaved roadways; and, • Natural dust (naturally eroded quartz, topsoil, agricultural soil).
DB 6	Nogajuka Primary School	
DB 7	Mehlamasha Combined School	

Notes:

[1] Possible contribution from sources are indicative

The monitoring period covered two cycles, Cycle 1 and Cycle 2, represented over two one-month periods. With respect to Cycle 1, samples were exposed from 16/11/2021 – 14/12/2021, with 28-days of exposure. Cycle 2 was conducted from 14/12/2021 – 13/01/2022, with samples exposed for 30 days. Both sampling periods comply with the standard exposure period of 30 ± 2 days and a valid sample return of 100% was achieved for both sampling periods.

The results of the dust fallout monitoring over both cycles at the residential monitoring locations are presented in Table 4-8 below with graphical representations shown in Figure 4-7 and Figure 4-8 for Cycles 1 and 2, respectively.

All measured values for Cycle 1 and Cycle 2 were below the standards set out in the Dust Control Regulations [4] with the exception of the Cycle 2 sample collected at monitoring location, DB 5, located at the Mxosheni Combined School region. A dust fallout rate of 927 mg/m^2/day was calculated which exceeded the dust fallout limit of < 600 mg/m^2/day [4] by 329 mg/m^2/day. The predominant wind direction, proximity to unpaved roadways and natural sources (wind erosion) could have resulted in migration of particulate matter towards the dust monitoring location, DB 5, however given that the value is an order of magnitude higher than the other samples collected, this is suspected to be due to highly localised dusty event (potentially even tampering) contributing to the exceedance at DB 5.

An average dust fallout rate of 173 mg/m^2/day was calculated across the sampling domain covering both monitoring cycles, and is considered indicative of background dust fallout rates.

Table 4-8 – Dust Fallout Monitoring Location Results

Monitoring Location ID	Location Description	Dust Fallout Limit (mg/m²/day, 30-day average) [4]	Dust Fallout Rate (mg/m²/day)	
			Cycle 1	Cycle 2
DB 1	Chenells Farm – Venture Compound	< 600	71	76
DB 2	Chenells Farm – Hillcrest 40 Block Compound	< 600	108	93
DB 3	Siyavuma Primary School	< 600	51	45
DB 4	Ngobese Homestead	< 600	207	65
DB 5	Mxosheni Combined School	< 600	202	927
DB 6	Nogajuka Primary School	< 600	413	46
DB 7	Mehlamasha Combined School	< 600	73	51
Average Dust Fallout Rate		**N/A**		**173**

Figure 4-7 – Dust Fallout Results for Cycle 1

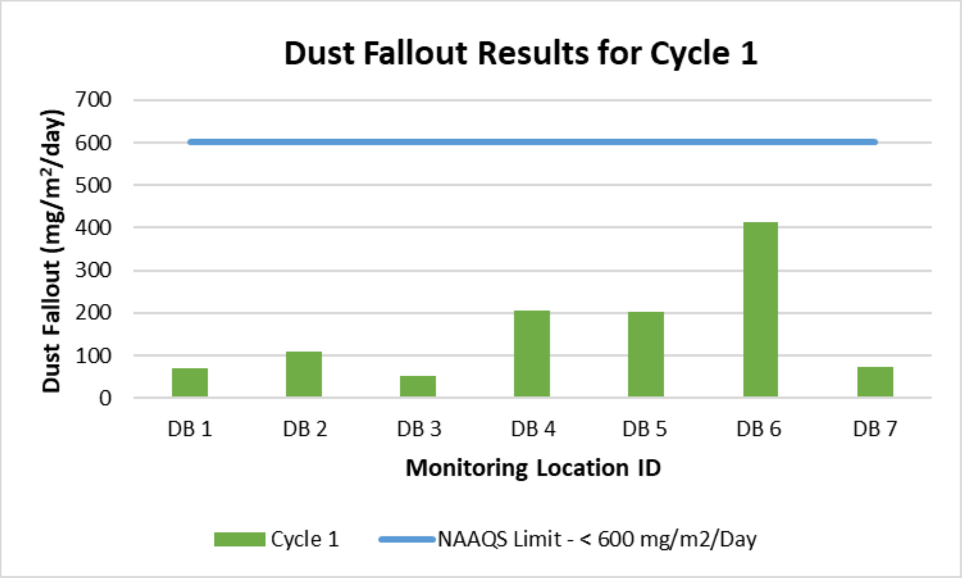
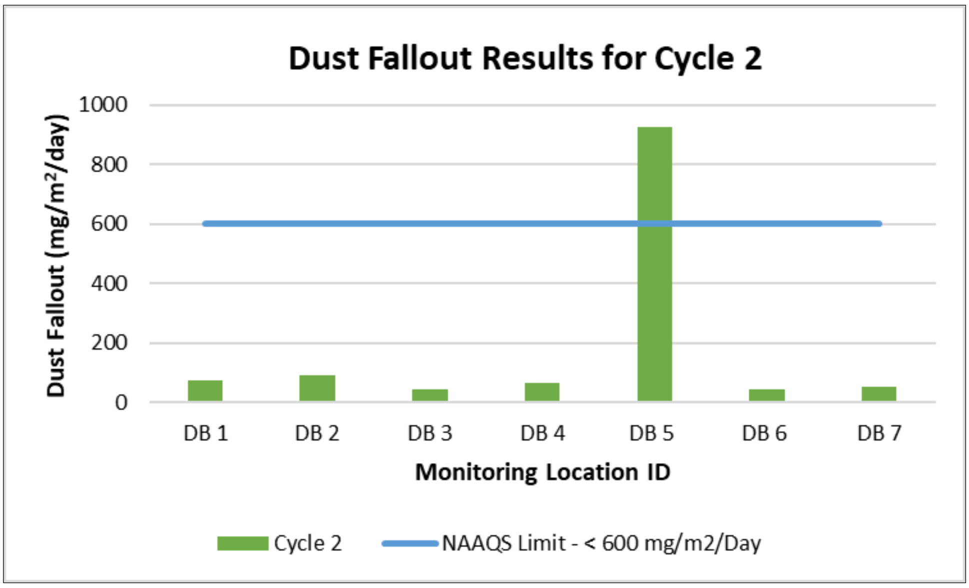


Figure 4-8 – Dust Fallout Results for Cycle 2



5 Modelling Procedures

5.1 Model Used in the Study Assessment

In order to estimate ground level concentrations (GLCs) for each pollutant, an Air Dispersion Model (ADM) was undertaken using Version 9.9.0 of AERMOD as recommended in the Code of Practice [3]. AERMOD is a straight-line, steady-state Gaussian plume model that can model the dispersion of pollutants over rural and urban areas, flat and complex terrain. AERMOD considers surface and elevated releases, and multiple sources (including, point, area and volume sources) to determine ground level pollutant concentrations at specified receptor points.

AERMOD is a new generation air quality modelling system, developed by the US EPA in collaboration with the American Meteorological Society. It contains improved algorithms for convective and stable boundary layers, for computing vertical profiles of wind, turbulence and temperature, and for the treatment of all types of terrain. One of the major improvements that AERMOD brings to applied dispersion modelling is its ability to construct vertical profiles of required meteorological variables, allowing improved modelling of the dispersion of pollutants (particularly of vertical dispersion).

AERMOD is the dispersion model recommended by the Department of Forestry, Fisheries and Environment (DFFE) for more sophisticated near-source applications in all terrain types (where 'near' is considered to be less than 50 km from source).

5.2 Modelled Emissions

5.2.1 Pollutants of Concern

Identified pollutant emissions have been assessed due to their known impact on human health and their potential to be released to the atmosphere from Project activities. Experience of assessing the exhaust emissions (products of combustion including NO_2, sulphur dioxide (SO_2) and CO from non-road mobile machinery and site traffic suggests that they are unlikely to make a significant impact on local air quality [1]. Therefore, the modelling assessment focuses on dust and fine particulate matter, as outlined below:

- PM: PM_{10} and $PM_{2.5}$ (fine PM with an aerodynamic diameter of less than 10 and 2.5 micrometres (µm), respectively) pose a health risk as the particles can penetrate deep into the lungs and may even enter the bloodstream. Exposure to such particles can affect both the lungs and heart; and,
- Dust and dust fall (deposition of dust), which usually constitutes a nuisance to those exposed, and has an impact on vegetation growth / agricultural activities.

5.2.2 Scenarios and Emissions

A single scenario representing the year with the largest mining throughput (Year 22) was considered. An assessment of the impact of PM_{10} and $PM_{2.5}$ emissions, associated with the Project as well as the deposition of TSP was undertaken.

5.2.3 Model Assumptions

The following assumptions have been made for the dispersion modelling assessment, and wherever possible, a conservative approach has been taken:

- The peak model year 2022 is representative of the reasonable worst case scenario;
- As the exact plant boundary has not yet been defined, and given the populated nature of the surrounding area, a 500 m buffer was established around the key mining areas (i.e. pit, internal roads, crusher and WRD). The assessment excluded all existing receptors within this zone;
- The trips per hour and associated dust emission rates of trucks hauling overburden have been based on the specific truck load capacities, and annual overburden volumes;
- UTM co-ordinates have been based on best approximation of the source locations from the Plot Plans provided;
- The moisture content of the ore has been established as approximately 7%. Therefore, high ore moisture content was considered for the development of the inventory;
- The particle size distribution (PSD) for ROM, overburden, discard and product material was based on information from similar mining processes [7];
- The average heights and width of haul route vehicles were sourced from the Caterpillar vehicle specification sheets for CAT748C vehicles;
- The approach to $PM_{2.5}$ quantifications is based on a percentage of PM_{10} emissions, which conservatively assumes that for grinding activities and fugitive dust sources (haul roads, material handling and transfer), just under 30% of the total PM_{10} emitted is composed of $PM_{2.5}$ fraction [8]; and,
- It must be noted that although AERMOD is equipped with algorithms for modelling dry deposition (dust fallout), there are inherent inaccuracies associated with the modelling of this pollutant. This is due to many limitations and uncertainties associated with model predicted deposition, and therefore model results should be treated as indicative. Additional information relating to the model uncertainties are outlined in the following section.

5.2.4 Uncertainties

Air quality models attempt to predict concentrations at a specific point and time based on “known” or measured values of various parameters input into the model, such as wind speed, temperature profiles, solar radiation. There are, however, variations in the “unknown” parameters that are not measured, as well as unresolved details of atmospheric turbulent flow. Variations in these “unknown” parameters can result in deviations of the predicted concentrations of the same event, even though the “known” parameters are fixed. As a result of the deviations of the “unknown” parameters, a “perfect” model may be able to predict an average of identical events well, while each repetition of that event will provide somewhat different results. The statistics of these concentration residuals are termed ‘‘inherent’’ uncertainty of a model.

In addition, there are “reducible” uncertainties due to inaccuracies in the model, errors in input values and errors in the measured concentrations. “Reducible” uncertainties include inaccuracies in the input values of the known conditions (for example, poor quality or unrepresentative meteorological, geophysical and source emission data); errors in the measured concentrations that are used to compare with model predictions and inadequate model physics and formulation used to predict the concentrations. As the term indicates, “reducible” uncertainties can be controlled or minimised by collecting accurate input data, preparing the input files correctly, checking and re-checking for errors, correcting for unexpected model behaviour, ensuring that the errors in the measured data are minimised and applying better model physics.

With regards to the modelling of mining activities, the confidence in model data is much lower than for the assessment of stationary combustion sources, where emission estimates are based on vendor data or legislated emission limits, with well-known parameters (such as exhaust volume flow rates, velocity, temperature and a fixed release height). In contrast the mining activities, vehicles, schedules and activities cover a much wider area, with an assumed extraction and operation schedule at a point in the future. Therefore, results should be treated as indicative, and not absolute. It is acknowledged that there will always be some error in any geophysical model, however notwithstanding the limitations and assumptions detailed, the structure of the modelling approach has been prepared in such a way as to minimise the total error.

5.3 Setting Utilized within the Model

The model settings are presented in Table 5-1.

Table 5-1 – Model Parameters

Model Settings	US EPA AERMOD Model 18081
	AERMET 18081
Model Domain	30 km x 30 km
MM5 Meteorological Data	4 km grid spacing
Terrain Settings	Shuttle Radar Topography Mission (SRTM) 30 Global 900 m data was included in the model
Land Use	The land classification within the model domain followed the Auer method specified in the Code of Practice [9] where the Project area was defined as rural. This is due to the area having has more than 35% vegetation coverage within a 3 km radius.
Land Characteristics	The average land use characteristics for rural land as specified in the Code of Practice [9] was adopted in the model.

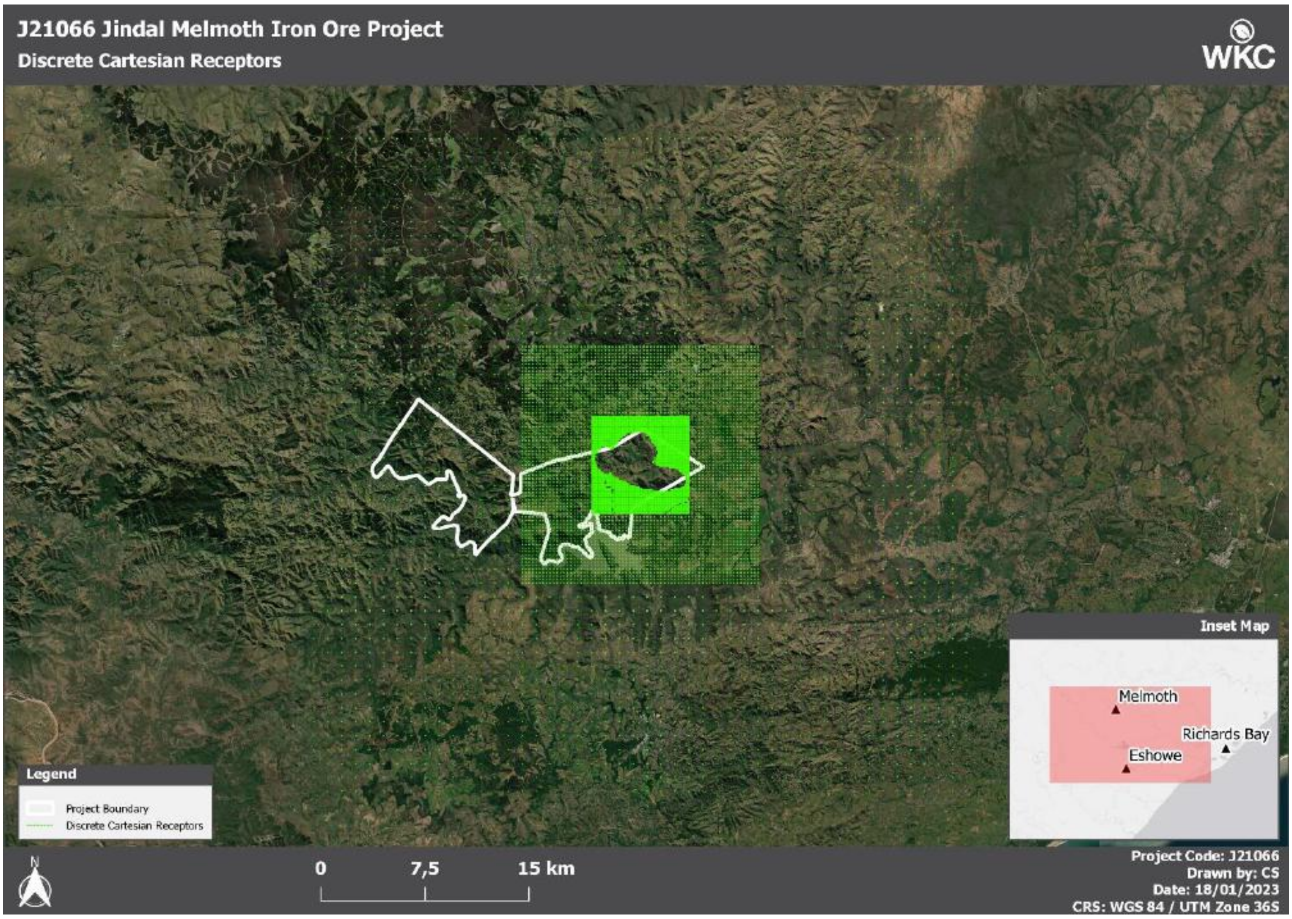
5.4 Model Domain and Receptors Grid

The model domain consists of four Cartesian (rectangular coordinate system) grids of receptor points in addition to site boundary receptor points, as follows.

- 50 km x 50 km, 1000 m resolution;
- 17 km x 17 km, 250 m resolution;
- 7 km x 7 km, 100 m resolution; and,
- 50 m resolution on the facility fence-line.

The receptor grid is presented in Figure 5-1.

Figure 5-1 – Receptor Domain



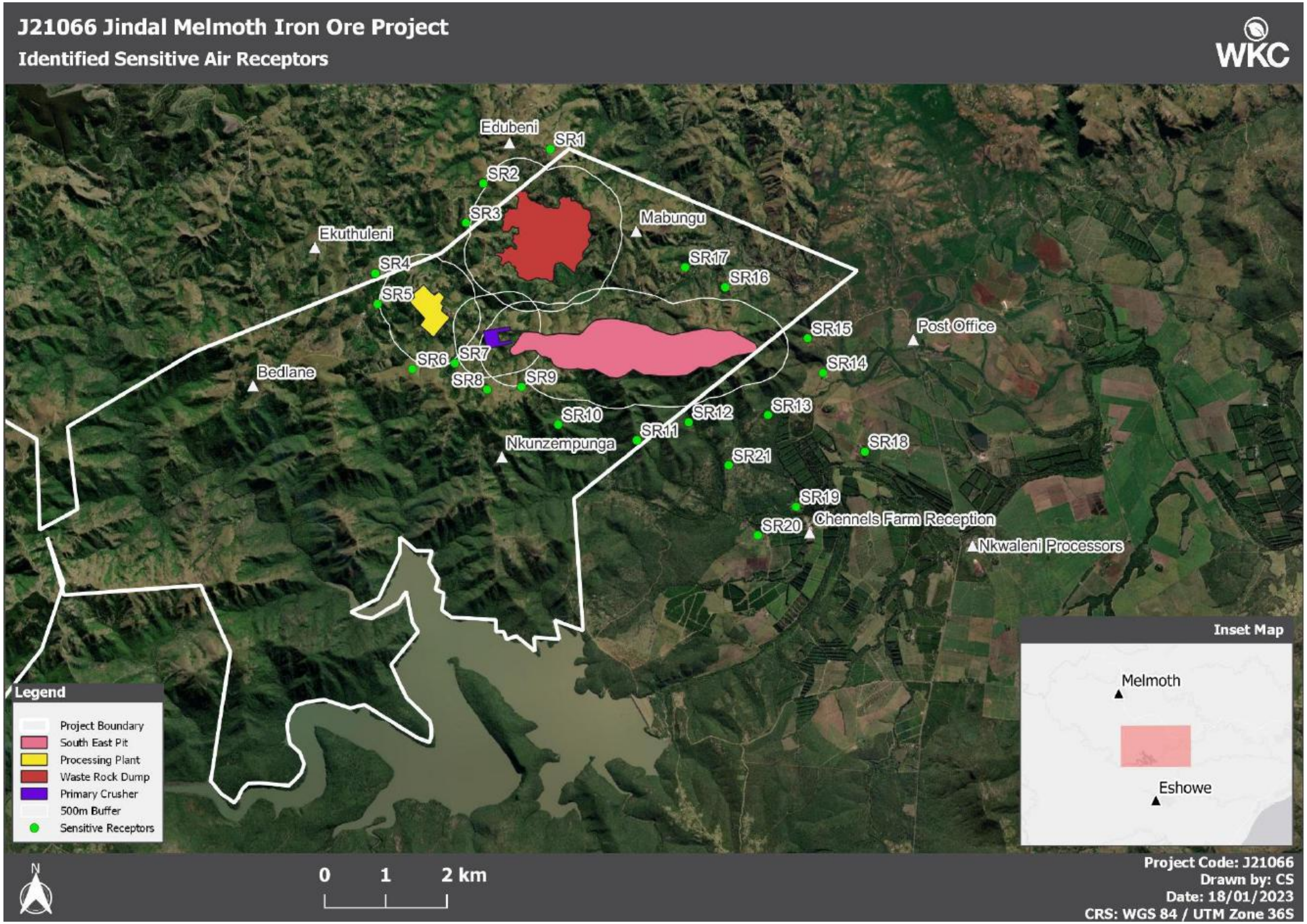
5.4.1 Sensitive Receptors

Sensitive receptors (SRs) have been identified and included in the assessment to determine the impact to areas of high receptor sensitivity. The sensitive receptors are listed below in Table 5-2 and are presented in Figure 5-2. As the exact Project boundary has not yet been defined, a 500 m buffer was placed around each of the key working areas, and it is assumed that no sensitive receptors would be located within this zone during the operations phase.

Table 5-2 – SRs

Site ID	Site Description	Distance from 500m Buffer Zone (m)	UTM Coordinates	
			m E	m N
SR 1	Homestead Cluster	103	350,520	6,825,570
SR 2	Homestead Cluster	194	349,352	6,825,184
SR 3	Homestead Cluster	49	348,972	6,824,590
SR 4	Homestead Cluster	214	347,376	6,824,004
SR 5	Homestead Cluster	25	347,335	6,823,502
SR 6	Homestead Cluster	137	347,736	6,822,365
SR 7	Homestead Cluster	66	348,433	6,822,352
SR 8	Homestead Cluster	226	348,890	6,821,841
SR 9	Homestead Cluster	29	349,455	6,821,798
SR 10	Homestead Cluster	421	349,949	6,821,097
SR 11	Homestead Cluster	586	351,180	6,820,644
SR 12	Homestead Cluster	268	352,064	6,820,804
SR 13	Homestead Cluster	561	353,367	6,820,720
SR 14	Farmland	652	354,363	6,821,255
SR 15	Homestead Cluster	356	354,204	6,821,858
SR 16	Homestead Cluster	211	352,998	6,822,891
SR 17	Homestead Cluster	522	352,405	6,823,312
SR 18	Farmland	1,947	354,840	6,819,875
SR 19	Farmland	2,155	353,588	6,819,160
SR 20	Farmland	2,368	352,896	6,818,795
SR 21	Homestead Cluster	1,158	352,603	6,820,002

Figure 5-2 – Identified Sensitive Air Receptors



6 Air Dispersion Modelling Results

6.1 Dispersion Modelling Results

The ADM results are reported against the regulated NAAQS for the various averaging periods. In accordance with the Code of Practice [1], for isolated facilities not influenced by significant background sources, the Project contribution has been assessed against the ambient air quality standards in isolation.

6.1.1 PM_{10} and $PM_{2.5}$ Model Results

The predicted maximum GLCs at SRs are summarised in Table 6-1. The 24-hour model values have been adjusted for the maximum allowable exceedances in accordance with the Code of Practice requirements. The modelled concentration contours for PM_{10} and $PM_{2.5}$ are presented in Figure 6-1 to Figure 6-4. The contour maps depict the model predicted pollutant concentrations by means of concentration contours with reference to the Project components, SRs and areas or particular interest/sensitivity. The model predicted concentrations at the SRs have been included within the contour maps with the following key:

- Red: concentration at the SR exceedance of the relevant NAAQS;
- Orange: concentration at the SR is less than 100% but greater than 25% of the relevant NAAQS; and
- Green: concentration at the SR is less than 25% of the relevant NAAQS.

The primary aim of the AAQS is to provide a uniform basis for the protection of public health and ecosystems from the adverse effects of air pollution, and to eliminate or reduce to a minimum, exposure to those pollutants that are known or likely to be hazardous. In terms of interpreting the contour plots, the Green and Orange contours are indicators of the areas that are likely to fall below the AAQS during the operational phase.

Table 6-1 – PM_{10} and $PM_{2.5}$ Maximum Ground Level Concentrations at SRs

Pollutant	PM_{10} Maximum Modelled GLC (µg/m³)		$PM_{2.5}$ Maximum Modelled GLC (µg/m³)	
Averaging Period	**24-hour (98.9%ile)**	**Annual**	**24-hour (98.9%ile)**	**Annual**
Project Ambient Air Quality Standard (µg/m³)	**75**	**40**	**25**	**15**
SR1	20.22	4.22	6.07	1.27
SR2	22.61	4.75	6.78	1.42
SR3	28.72	6.95	8.62	2.09
SR4	33.15	5.30	9.94	1.59
SR5	35.56	5.50	10.67	1.65
SR6	34.00	8.02	10.20	2.41
SR7	158.03	38.99	47.41	11.70
SR8	35.40	10.75	10.62	3.22
SR9	62.89	16.55	18.87	4.97
SR10	109.15	28.41	32.74	8.52
SR11	125.31	29.33	37.59	8.80
SR12	157.09	30.00	47.13	9.00
SR13	95.68	15.18	28.71	4.55
SR14	83.36	11.21	25.01	3.36
SR15	77.15	11.96	23.15	3.59
SR16	80.33	16.12	24.10	4.84
SR17	77.47	17.95	23.24	5.39
SR18	58.49	8.05	17.55	2.41
SR19	69.66	9.25	20.90	2.77
SR20	56.58	9.86	16.98	2.96
SR21	95.52	15.65	28.66	4.69

Key:		
	(green)	Less than 25% of the relevant AAQS
	(amber)	Between 25% and 100% of the AAQS
	Red Text	Exceeds Relevant AAQS

Figure 6-1 – PM_{10} 24 hour Averaging Period Modelled Concentrations

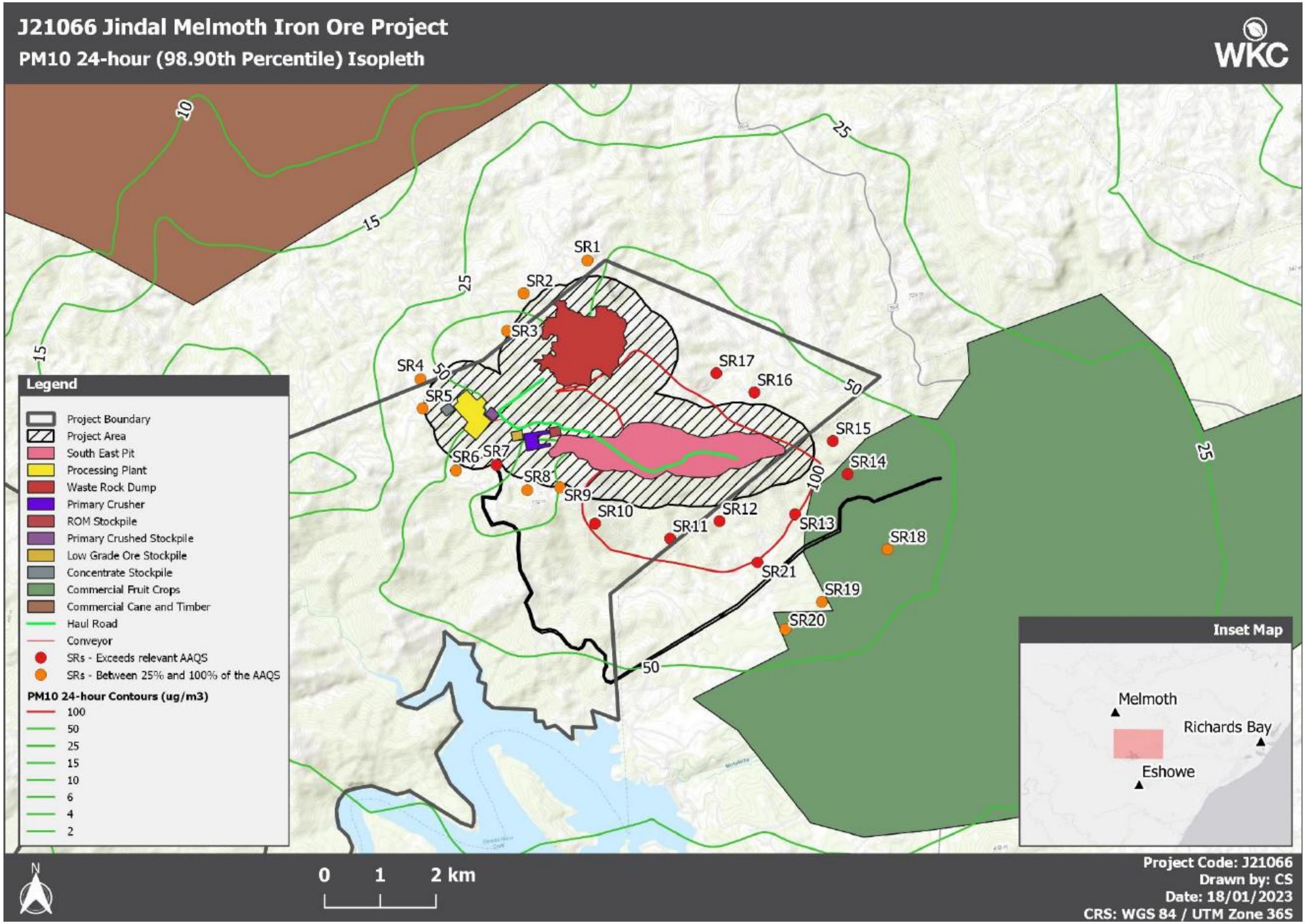


Figure 6-2 – PM_{10} Annual Averaging Period Modelled Concentrations

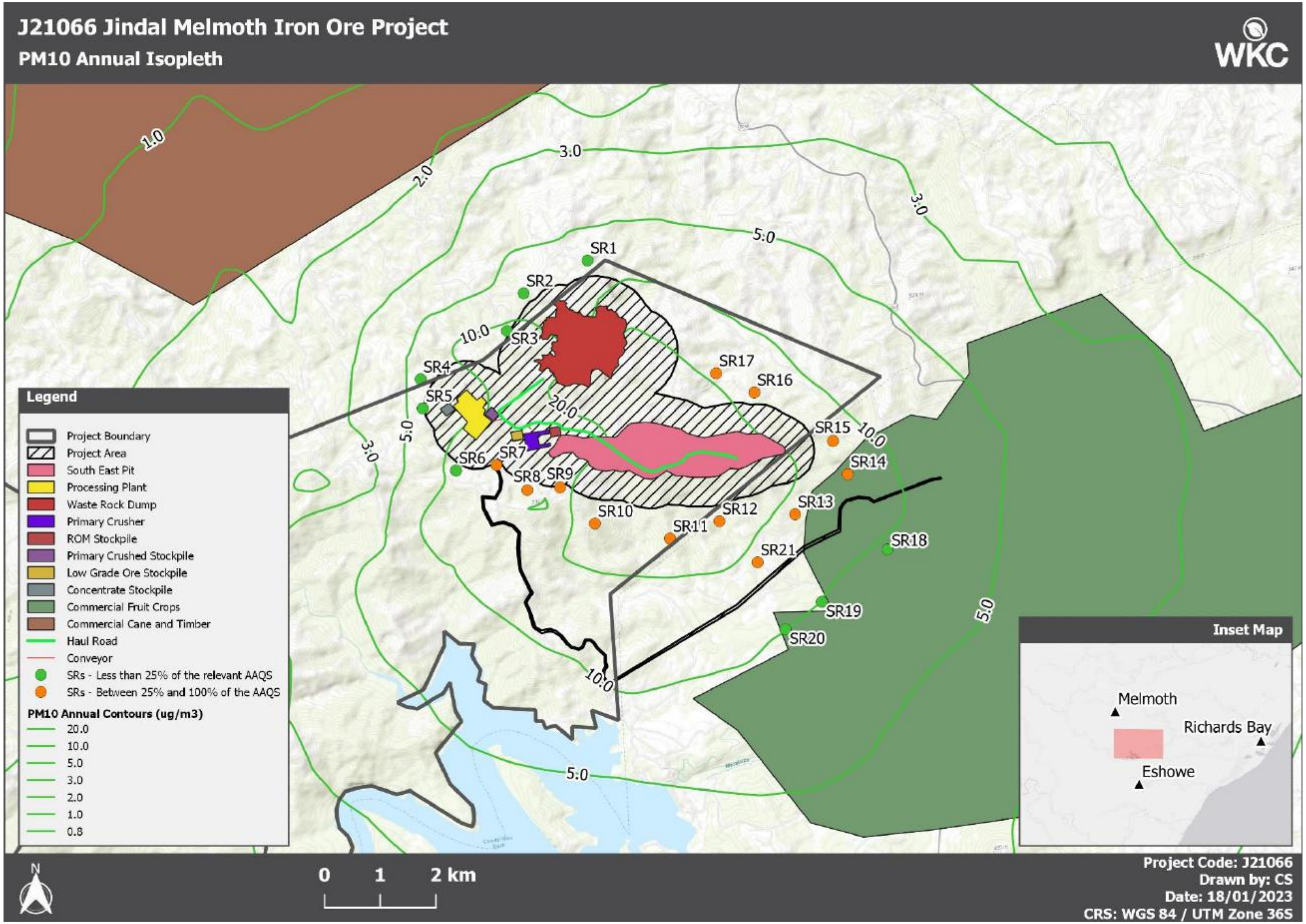


Figure 6-3 – $PM_{2.5}$ 24 hour Averaging Period Modelled Concentrations

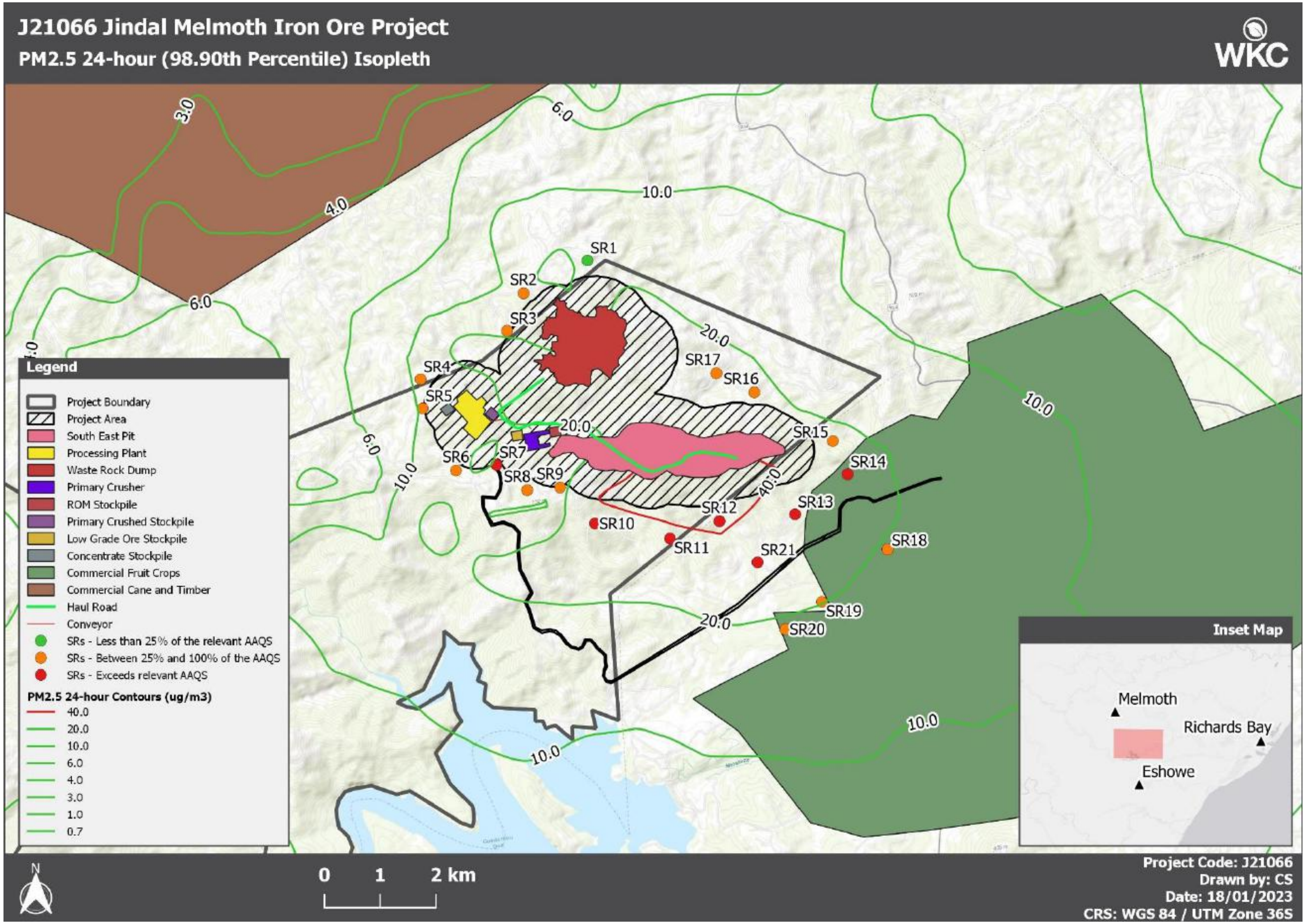
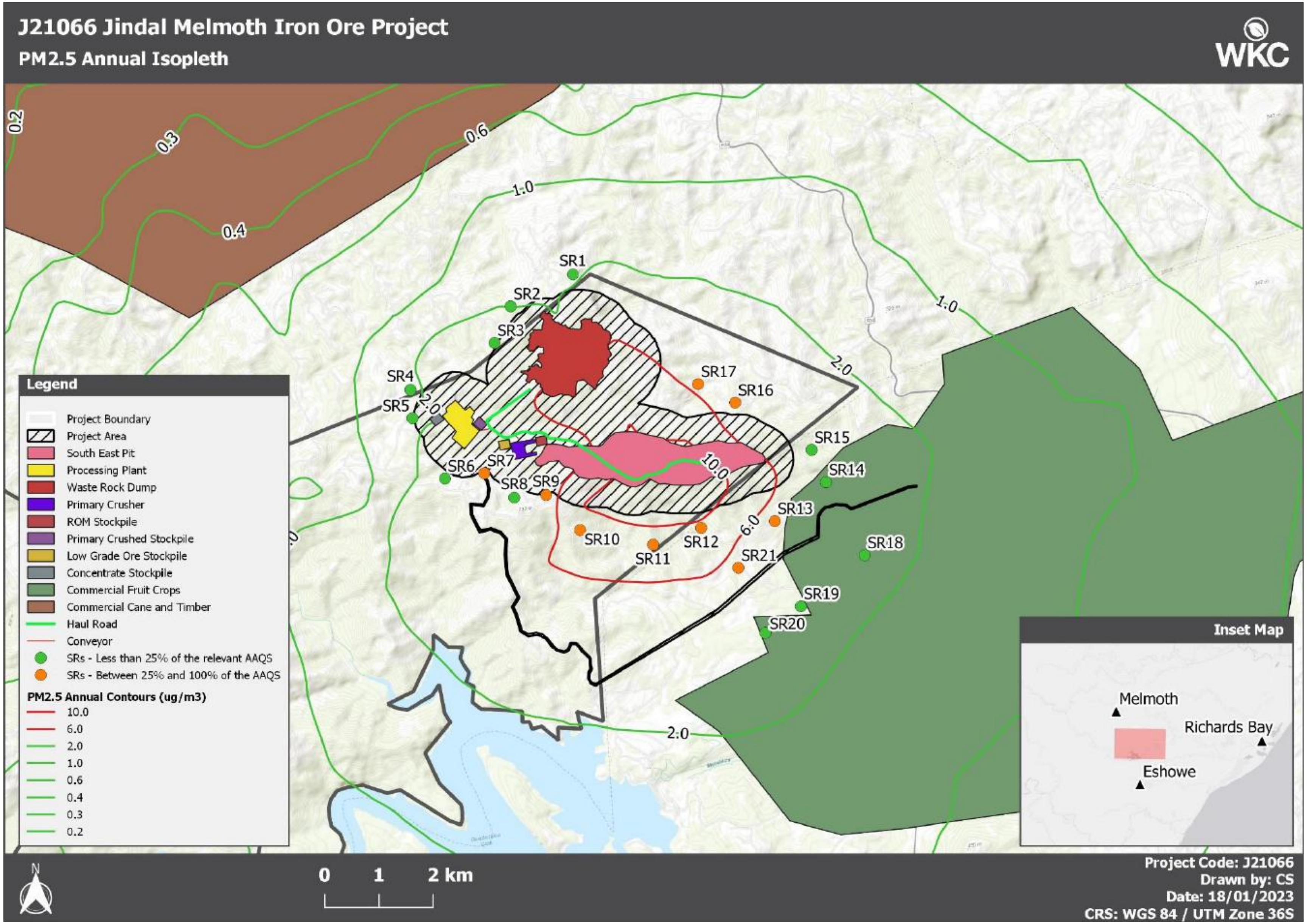


Figure 6-4 – $PM_{2.5}$ Annual Averaging Period Modelled Concentrations



6.1.2 Dust Fallout Model Results

Although AERMOD is equipped with algorithms for modelling dry deposition (dust fallout), inherent inaccuracies are associated with the modelling of this pollutant, given the relatively simplistic methods that are used to simulate fallout rates. This is due to many limitations and uncertainties associated with the number of assumptions required to facilitate the model run. As such, a range of values, representing the upper and lower range, has been provided as opposed to a single value. The range was obtained by considering results for both the unmitigated and mitigated emission rates for mining activities. The deposition rates at SRs are summarised in the table below (Table 6-2) and compared against the dust fallout standard. The model predicted dust fallout rates for the Upper and Lower predicted ranges are presented in Figure 6-5 and Figure 6-6, respectively. These maps indicate the model predicted concentrations with reference to the Project components, SRs and areas of interest/sensitivity. The model predicted concentrations at the SRs have been included within the contour maps with the following key:

- Red: concentration at the SR exceedance of the relevant NAAQS;
- Orange: concentration at the SR is less than 100% but greater than 25% of the relevant NAAQS; and
- Green: concentration at the SR is less than 25% of the relevant NAAQS.

It should be noted that the dust fallout AAQS are set primarily for prevention of nuisance and soiling and are not associated with impacts to community health.

Table 6-2 – TSP Maximum Ground Level Concentrations at SRs

Pollutant	Dust-fall (mg/m²/day, 30 day average)*	
Permitted Dust-fall Rate (D) (mg/m²/day, 30-day average)	< 600	
	Upper Predicted Range	Lower Predicted Range
SR1	69.82	32.29
SR2	111.05	50.23
SR3	184.70	81.99
SR4	214.78	82.54
SR5	247.21	99.28
SR6	249.87	108.12
SR7	477.62	192.88
SR8	302.31	112.14
SR9	355.60	124.36
SR10	261.10	84.17
SR11	237.67	75.85
SR12	242.06	76.73
SR13	121.31	37.80
SR14	165.31	51.02
SR15	141.72	46.40
SR16	123.95	44.25
SR17	133.26	52.84
SR18	50.09	17.45
SR19	57.74	19.61
SR20	64.68	22.72
SR21	110.63	36.44

Key:		
	(green)	Less than 25% of the relevant AAQS
	(orange)	Between 25% and 100% of the AAQS
	Red Text	Exceeds Relevant AAQS (600 mg/m²/day, 30-day average**)**

*2 permitted exceedance per year, not in sequential months

Figure 6-5 – Dust Fallout Model Deposition Rates for Upper Predicted Range (mg/m²/day)

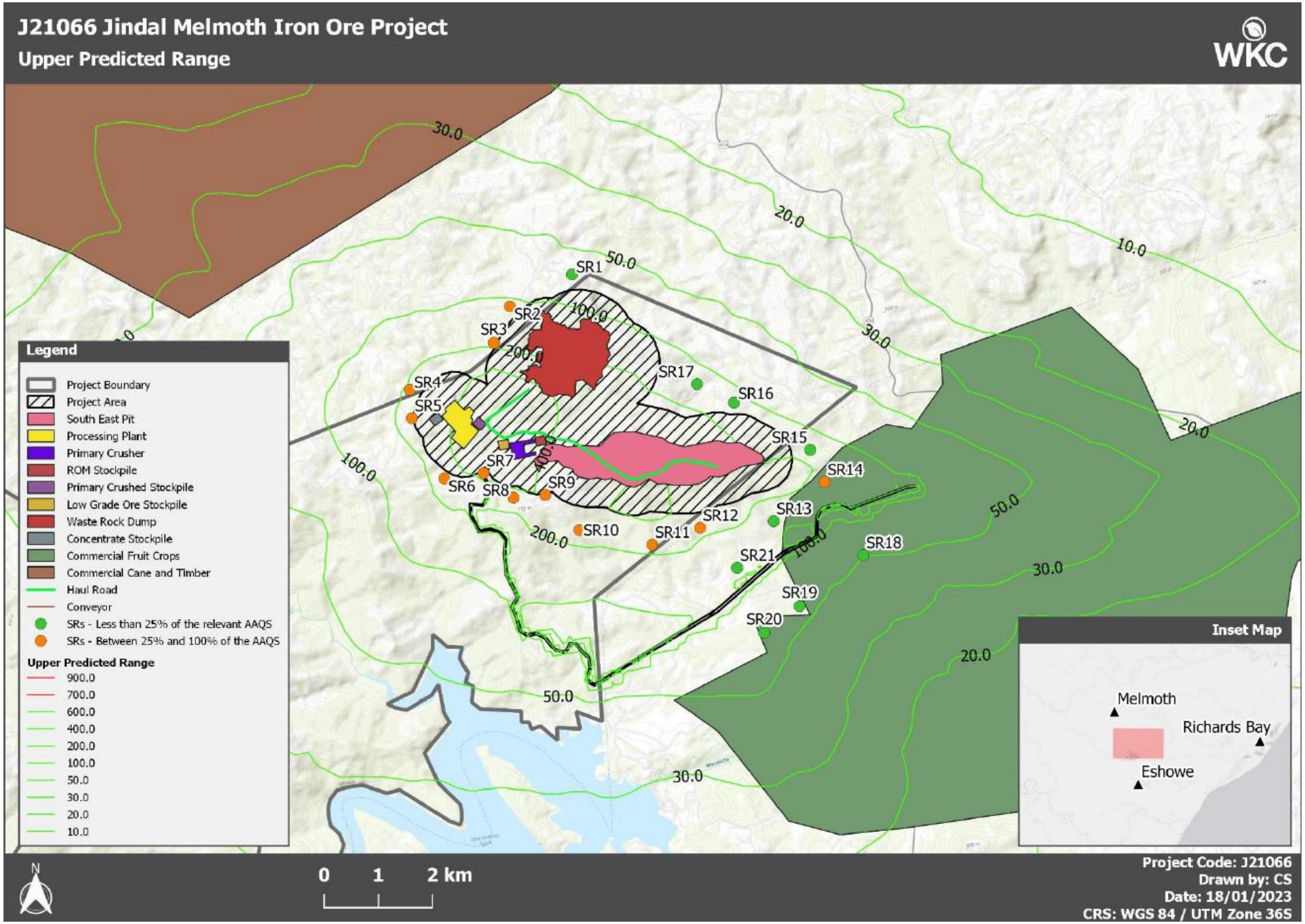
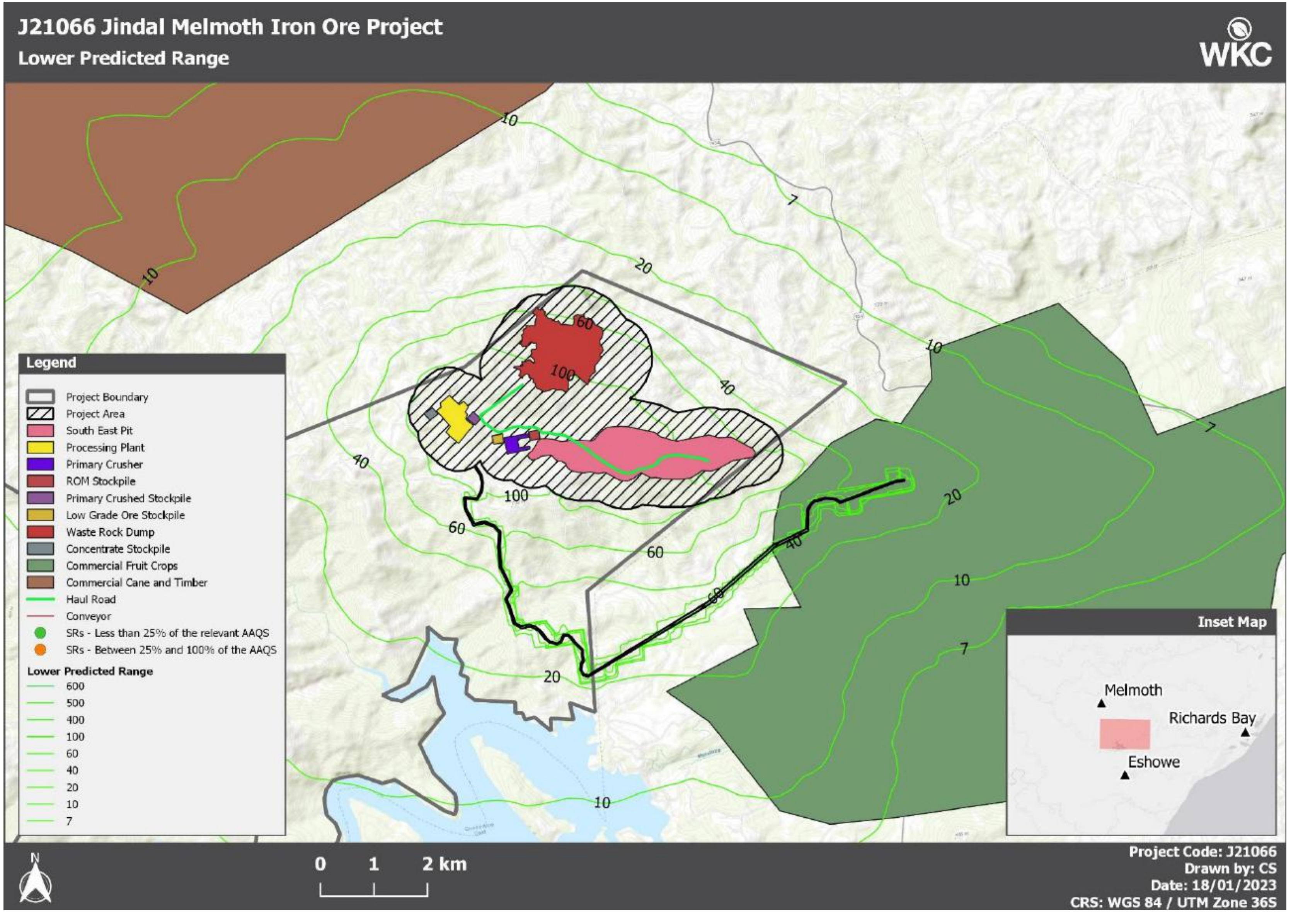


Figure 6-6 – Dust Fallout Model Deposition Rates for Lower Predicted Range (mg/m²/day)



7 Air Quality Impact Assessment

7.1 Construction Phase Assessment

The construction of the mine and associated infrastructure will lead to emissions of fugitive dust which could potentially impact on surrounding receptors.

Atmospheric emissions surrounding the site can be broadly categorised into the following:

- Dust from earth working and onsite vehicle movement activities;
- Emissions associated with construction vehicles transporting materials and personnel to and from the site, i.e., offsite emissions (e.g., construction vehicles, transport of workers and delivery vehicles); and,
- Emissions associated with construction activities onsite (e.g., equipment, heavy machinery, vehicle idling, and dust emissions).

These potential sources of emissions and resultant impacts are considered to be relatively universal across the different phases of construction.

7.1.1 Dust Emission Magnitude

As recommended in the assessment guidance, WKC professional judgement and experience has been applied in this assessment to correlate the Project specifics to the pre-defined impact magnitude categories, classed as large, medium or small, based on criteria provided in the Institute of Air Quality Management (IAQM) guidance [10]. The assessment criteria is detailed in Appendix D. The results of the assessment are summarised below.

Demolition

The Project site is currently undeveloped, so there will be limited requirement to undertake any demolition activities. Demolition is therefore “**Not Applicable (N/A)**”.

Earthworks

The total Project construction area footprint is classified as “large” according to IAQM criteria as the total site area is >10,000 m^2 and because it is considered likely that there will be more than 10 heavy earthmoving vehicles to operate on-site at any given time. The soil type has been assumed to be potentially dusty. Overall, it has been estimated that the unmitigated magnitude of dust and PM_{10} emissions is considered “**Large**” for earthworks activities.

Construction

The total volume of buildings to be constructed on the site is expected to be more than 25,000 m^3. Therefore, the magnitude of dust and PM_{10} emissions is considered large for construction activities.

Track-out

There is potential for there to be >50 heavy duty vehicle (HDV) outward movements in any one day during the construction period. In addition, the unpaved road surface material is likely to have a high potential for dust release and the majority of the roads to be traversed by construction vehicles will be unpaved and greater than 100 m in length. Therefore, it is conservatively considered that the unmitigated magnitude of dust and PM_{10} emissions is "**Large**" for track-out.

Summary of Dust Emission Magnitude

A summary of the dust emission magnitude for each of the four construction categories is presented in Table 7-1.

Table 7-1 – Dust Emission Magnitude

Activity	Description	Dust Emission Magnitude
Demolition	N/A	N/A
Earthworks	Total area >10,000 m^2, > 10 heavy earth moving vehicles, total material moved >100,000 tonnes	Large
Construction	Total building volume >25,000m^3	Large
Track-out	> 50 HDV per day, > 100 m unpaved roads	Large

7.1.2 Assessment of Sensitivity of the Study Area

Sensitivity to Dust Soiling Effects on People and Property and Human Health (PM_{10})

The construction site will be located a minimum of 500 m away from the community members, given the buffer between the mine boundary and nearest receptors, and therefore receptor sensitivity is expected to be "**Low**". However, construction vehicles are likely to use the access roads in the vicinity of the mine, where it is assumed , based on observations from the most recent Google Earth imagery, that there will be more than 100 receptors located within 50 m of the construction and access roads. Taking into account the IAQM guidance [10], the area surrounding the Project site is considered to be of low sensitivity, and people living adjacent to the access roads are considered to be of "**High**" sensitivity[1] to changes in dust and PM_{10} as a result of construction activities.

Table 7-2 – Human Receptor Sensitivity

Receptors	Sensitivity Classification (People and Property)
Community (Construction)	Low
Receptors adjacent to access / haul roads (Trackout)	High

Ecological and Agricultural Sensitivities

Dust deposition due to demolition, earthworks, construction and trackout has the potential to affect sensitive habitats and plant communities. Dust can have two types of effect on vegetation: physical and chemical. Direct physical effects include reduced photosynthesis, respiration and transpiration through smothering. Chemical changes to soils or watercourses may lead to a loss of plants or animals, for example via changes in acidity.

[1] Examples of high sensitivity receptors include locations where people can be reasonably expected to be present for extended periods. For PM_{10} in the case of 24-hour objectives, a relevant location would be one where individuals may be exposed for eight or more hours in a day.

Indirect effects can include increased susceptibility to stresses such as air pollution in the form of PM from construction activities. These changes are likely to occur only as a result of long-term construction works adjacent to ecological and agricultural sensitivities such as the nearby farmlands. Often impacts will be reversible once the works are completed, and dust emissions cease.

In accordance with the IAQM methodology, and the minimum distance of the nearest commercial farms (+-1km) the ecological and agricultural sensitivity for the area is considered to be of "**Medium**" sensitivity, as the nearby agricultural farms are locations where there is a particularly important plant species from an economic perspective such as citrus fruit and sugar cane, and where the dust sensitivity of the species is uncertain or not well documented.

Outcome of Defining the Sensitivity of the Area

A risk assessment was undertaken to determine the risk associated with each of the construction activity categories; the results of which are summarised in Table 7-3.

Table 7-3 – Overall Area Sensitivity Summary

Potential Impact	Sensitivity of the Surrounding area			
	Demolition	Earthworks	Construction	Track-out
Dust Fallout / Soiling	N/A	Low	Low	High
Human Health	N/A	Low	Low	High
Ecological and Agricultural	N/A	Low	Low	Medium

7.1.3 Overall Risk Category

The risk category identified for each activity is established to determine the risk of impacts with no mitigation applied for each relevant construction component in accordance with the assessment methodology detailed in Appendix D. The risk categories are presented in Table 7-4.

Table 7-4 – Construction Impact Assessment Risk Categories

Potential Impact	Risk			
	Demolition	Earthworks	Construction	Track-out
Dust Fallout / Soiling	N/A	Low Risk	Low Risk	High Risk
Human Health	N/A	Low Risk	Low Risk	High Risk
Ecological and Agricultural	N/A	Low Risk	Low Risk	Medium Risk

Taking into account all of the above and given the 500 m buffer between the mine site and receptors, the key dust related issues for the construction phase are expected to relate to vehicle trackout and unpaved roads.

7.1.4 Mitigation / Enhancement Measures

The following measures should be implemented:

- Hard surfacing the main mine access road;
- Wet suppression of stockpiles when necessary (including wind shielding, storage away from site boundaries, and restricted height of stockpiles)

- Restricting vehicle speeds on haulage routes and other unsurfaced areas of the site;
- Ensuring that vehicles carrying dry soil and other materials are covered during travel;
- Best practices adopted to control emissions from loading and dumping material include water application, minimisation of drop heights and suspension or modification of activities during adverse weather conditions;
- Increase frequency of site inspections by the responsible person for air quality and dust issues on site when activities with a high potential to produce dust are being carried out;
- Restrict vehicle access to defined areas to avoid unnecessary off-road vehicle movements outside of the active work sites;
- Implement methods of reducing wind speed around potentially dusty activities / areas. Early planting of site perimeter areas with native tree species, and / or the strategic use of 'snow fencing' will potentially reduce wind speed across the site; and,
- Display details of responsible person for air quality and dust issues at the site boundary.

7.1.5 Monitoring

The following monitoring is recommended:

- Daily inspection to ascertain the need for wet suppression and its subsequent implementation;
- Grading activities should be monitored on a daily basis; and,
- Weekly inspection of unsurfaced haulage routes. Daily inspection should be undertaken during particularly dry periods to determine the need for wet suppression. .

7.2 Operations Phase Assessment

In terms of effects, mines can give rise to annoyance factors due to the soiling of surfaces by dust from mining activities including ore handling and processing, blasting and from unpaved roads and exposed surfaces. Very high levels of soiling can also damage plants and affect the diversity of ecosystems. Additionally, exposure to PM_{10} and $PM_{2.5}$ has long been associated with a range of health effects. The following sections provide a summary of the impact assessment tables as per the SLR methodology. The assessment is informed though both quantitative means (i.e., dispersion modelling) and qualitative means (literature review).

7.2.1 Impacts to Community Health

An analysis of emissions impact on human health and the environment is achieved using the air dispersion modelling results (Section 6), and the NAAQS which have been set for the protection of both human health and the environment. These standards serve to indicate what levels of exposure to pollution, as a result of dust emissions from project activities, are generally safe for most people, including vulnerable groups, over their entire lifetimes. The closest SRs are located less than 100 m from the Project area, and those that are expected to be most affected by the Project, as shown in Figure 6-1 to Figure 6-4, are those located along the southeast, south and southwest of the project boundary (SR7,SR10-17, SR19 and SR21) as these SRs are located closest to the haul road and the southeast pit which are predicted to be the key sources of dust. At SRs locations where the NAAQS predicted to be exceeded, the impact to community health is considered high, prior to the implementation of additional mitigation, and can be reduced medium with the implementation of the recommended additional mitigation measures. It is also noted that the development may require a resettlement programme, which may negate impacts at certain locations (as the receptors will no longer be present), however at this stage the exact scope and nature has not yet been defined.

Other locations of concern are where the modelled concentrations are not predicted to exceed the standard, but still constitute more than 25% of the standard. A theoretical example of this would be where the standard is 100 µg/m^3 and the model value is 26 µg/m^3 , 26 µg/m^3 is greater than 25% of the standard (which would be 25 µg/m^3). With regards to the areas where the model predicted values fall within this theoretical zone (i.e. between 25 and 100% of the standard). The impact assessment shows a medium impact prior to the implementation of additional mitigation and low subsequent to its implementation.

In order to contextualise the model results, an impact assessment has been undertaken using the SLR impact assessment rating methodology. Refer to the EIA report for the full impact assessment methodology. The impact assessment is presented in Table 7-5.

Table 7-5 – EIA Impact Assessment – Community Health

Issue: Exceedance of the Short-term and/ or Long-Term PM_{10} and $PM_{2.5}$ NAAQS at SR7, SR10-SR17, SR19 and SR21 (Figure 6-1) and the resultant impact on human health		
Phase: Operations Phase		
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	High	Medium
Duration	Long-term	Long-term
Extent	Local	Local
Consequence	High	Medium
Probability	Definite / Continuous	Definite / Continuous
Significance	High	Medium
Degree to which impact can be reversed	The impacts are reversable with the implementation of mitigation measures, or ceasing of activities	
Degree to which impact may cause irreplaceable loss of resources	Unlikely, with the implementation of management action.	
The following mitigation actions are recommended	• Establish exact boundaries for any proposed resettlement activities, as this may overlap with receptors associated with high impact significance • Preparation of a dust management plan as part of the Project Environmental Management Programme (EMPr); • Addition of surfactants and dust suppressants when watering, specifically in working areas takes place close to the project boundaries; • Large trees and thick indigenous vegetation (in consultation with the project ecologist) to be established along the Project boundary to reduce wind speeds and provide visual buffer between mining activities and community; • Reduce vehicle speeds to 30 km/hr or below on all internal haul routes and roads; • Utilise chutes at material handling transfer points; • While the processing plant will be enclosed, all bag filters on extraction points should be designed for 30 mg/Nm^3 • Ensure that vehicles carrying dry soil and other materials are covered during travel; and, • Cover the surface of haul routes with less erodible aggregate material such as compacted and treated crusher run / aggregate.	
The following monitoring is recommended	• Install at least two continuous analyzers (for PM_{10} and $PM_{2.5}$) at the Project boundary (or at other suitable locations such as homesteads), one upwind and one downwind as proposed in Figure 7-1; • Install dust fallout gauges at a minimum of 8 locations (principal wind directions) as proposed in Figure 7-2, with monitoring commencing at least one year before the construction commences; and, • Implement a community engagement and complaints / grievance mechanism.	

Issue: Short-term and Long-Term PM_{10} and $PM_{2.5}$ > 25% of NAAQS at SR1-6, SR8, SR9, SR18 and SR20 (Figure 6-1) and the resultant impact on human health		
Phase: Operations Phase		
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Medium	Low
Duration	Long-term	Long-term
Extent	Local	Local
Consequence	Medium	Low
Probability	Definite / Continuous	Definite / Continuous
Significance	Medium	Low
Degree to which impact can be reversed	The impacts are reversable with the implementation of mitigation measures, or ceasing of activities	
Degree to which impact may cause irreplaceable loss of resources	Unlikely, with the implementation of management action.	
The following mitigation actions are recommended	• Preparation of a dust management plan as part of the Project EMPr; • Addition of surfactants and dust suppressants when watering; • Large trees and thick indigenous vegetation to be established along the Project boundary to reduce wind speeds and provide visual buffer between mining activities and community; • Reduce vehicle speeds to 30 km/hr or below on all internal haul routes and roads; • Utilise chutes at material handling transfer points; • Ensure that vehicles carrying dry soil and other materials are covered during travel; and, • Cover the surface of haul routes with less erodible aggregate material such as compacted and treated crusher run / aggregate.	
The following monitoring is recommended	• Install at least two continuous analysers (for PM_{10} and $PM_{2.5}$) at the Project boundary (or at other suitable locations such as homesteads), one upwind and one downwind as proposed in Figure 7-1; • Install dust fallout gauges at a minimum of 8 locations (principal wind directions) as proposed in Figure 7-2, with monitoring commencing at least one year before the construction commences; and, • Implement a community complaints / grievance mechanism.	

Figure 7-1 – Proposed Continuous Analyser Locations

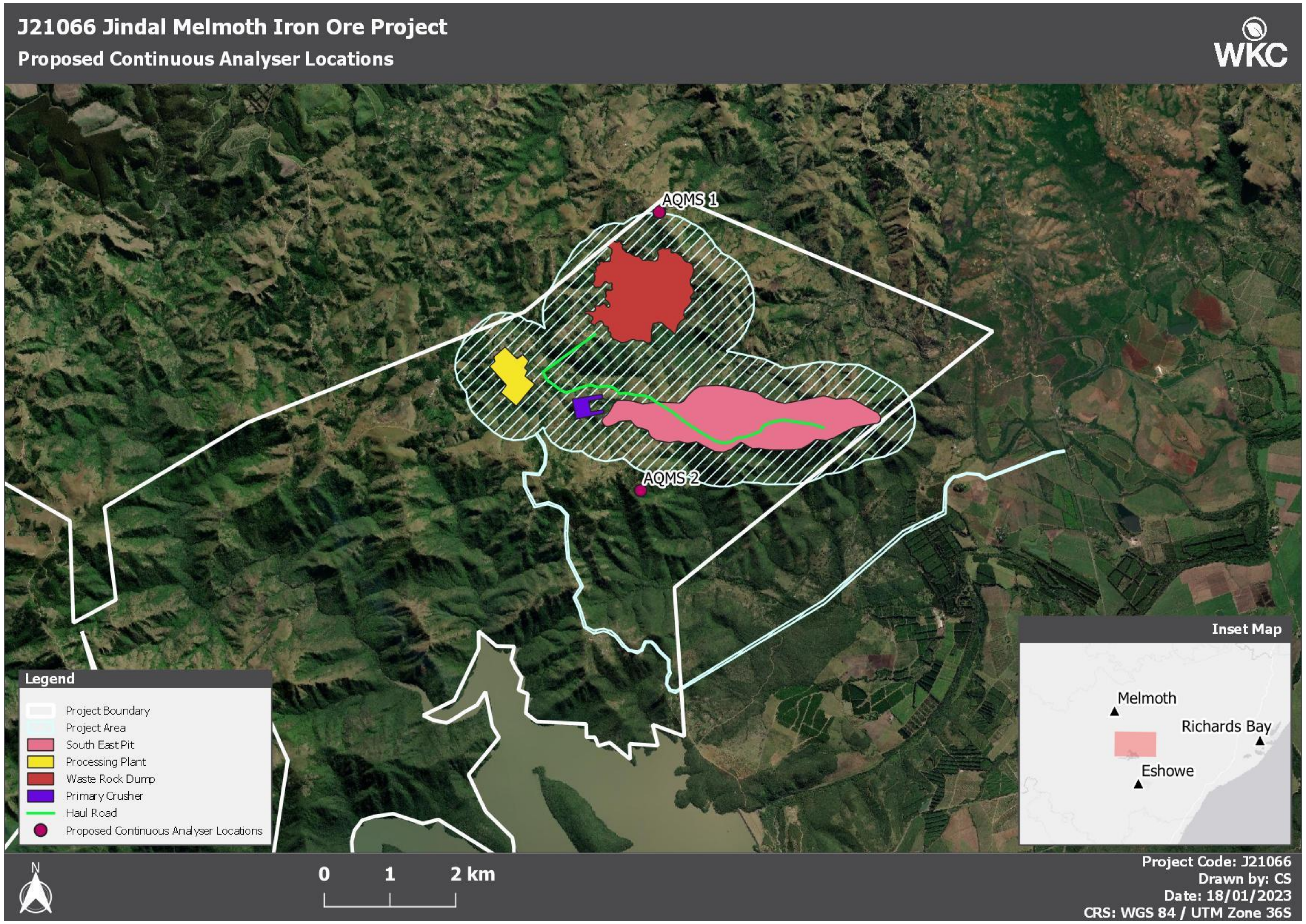
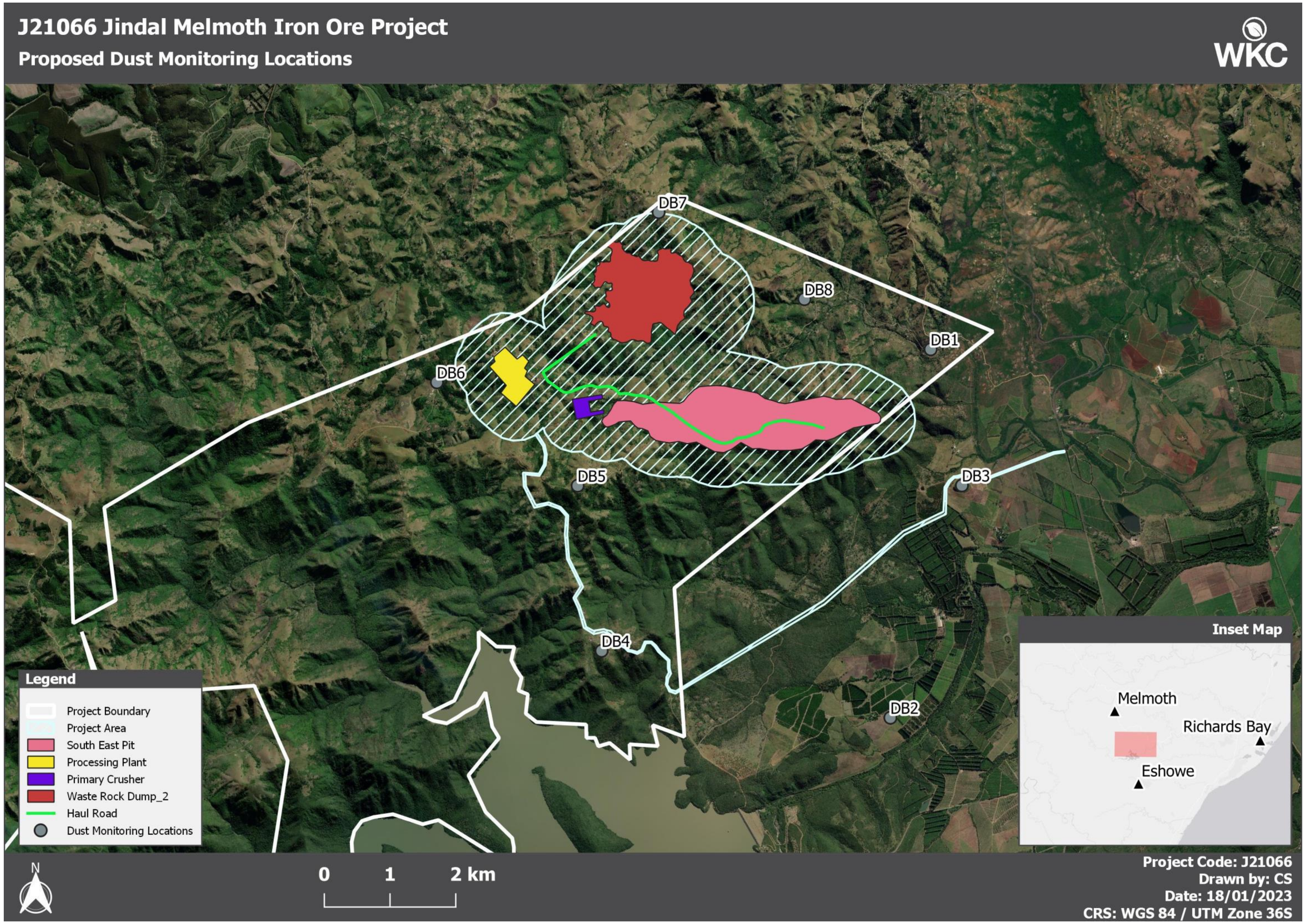


Figure 7-2 – Proposed Dust Bucket Locations



7.2.2 Impacts to Agricultural Vegetation

Dust from mining sites deposited on vegetation may create ecological stress on commercial agricultural activities. During long dry periods dust can coat plant foliage adversely affecting photosynthesis and other biological functions. Large scale mining activities may give rise to dust deposition over an extended period of time, creating the potential to adversely affect commercial crops. The air dispersion modelling study indicates that dust fallout (in excess of the national standards) from the Project is unlikely to travel the distances required to impact the nearest commercial crops (at a distance of +- 1 km), as the larger particles associated with soiling will settle out within this distance. In addition the nearest forestry plantations are more than 3km away and beyond the likely zone of influence (as shown in Figure 6-5, Figure 6-6 and Figure 7-3).

Give the distance between source (mine) and receptor (crops), and the larger size of the dust particle associated with dust deposition nuisance, the impact of dust fallout on agricultural vegetation is predicted to be low prior to the implementation and very low after mitigation. It should, however, be noted that the mine access road (linking the R66 with the eastern corner of Goedertrouw Dam, to the mine site) passes through both citrus and cane fields and is likely to be used by the community as well as for mine vehicle access. At present this road is not paved and could therefore lead to localised dust deposition impacts in close proximity to the road, given the increase in traffic flows and heavy vehicles. A comparison of the various control options for the main access road is provided in Table 7-6. Paving the main access road (which passes through agricultural areas) will reduce TSP emissions by approximately 200 tonnes per annum, as dust emissions from paved roads will be negligible in comparison to unpaved roads. Therefore, it is recommended that the main access road should be paved as part of the design basis. The detailed impact assessment is presented in Table 7-7.

Table 7-6 – Access Road Dust Control Mitigation Comparison

	Design Mitigation Control Efficiency	**Total Emissions (TPA)**
Access Road TSP Emissions	50% for level 1 watering (2 litre/m^2/hour)	208
	75% for level 2 watering (< 2 litre/m^2/hour)	103
	100% for sealed roads	Negligible

Figure 7-3 – Buffer Distances Between Mine and Receptors

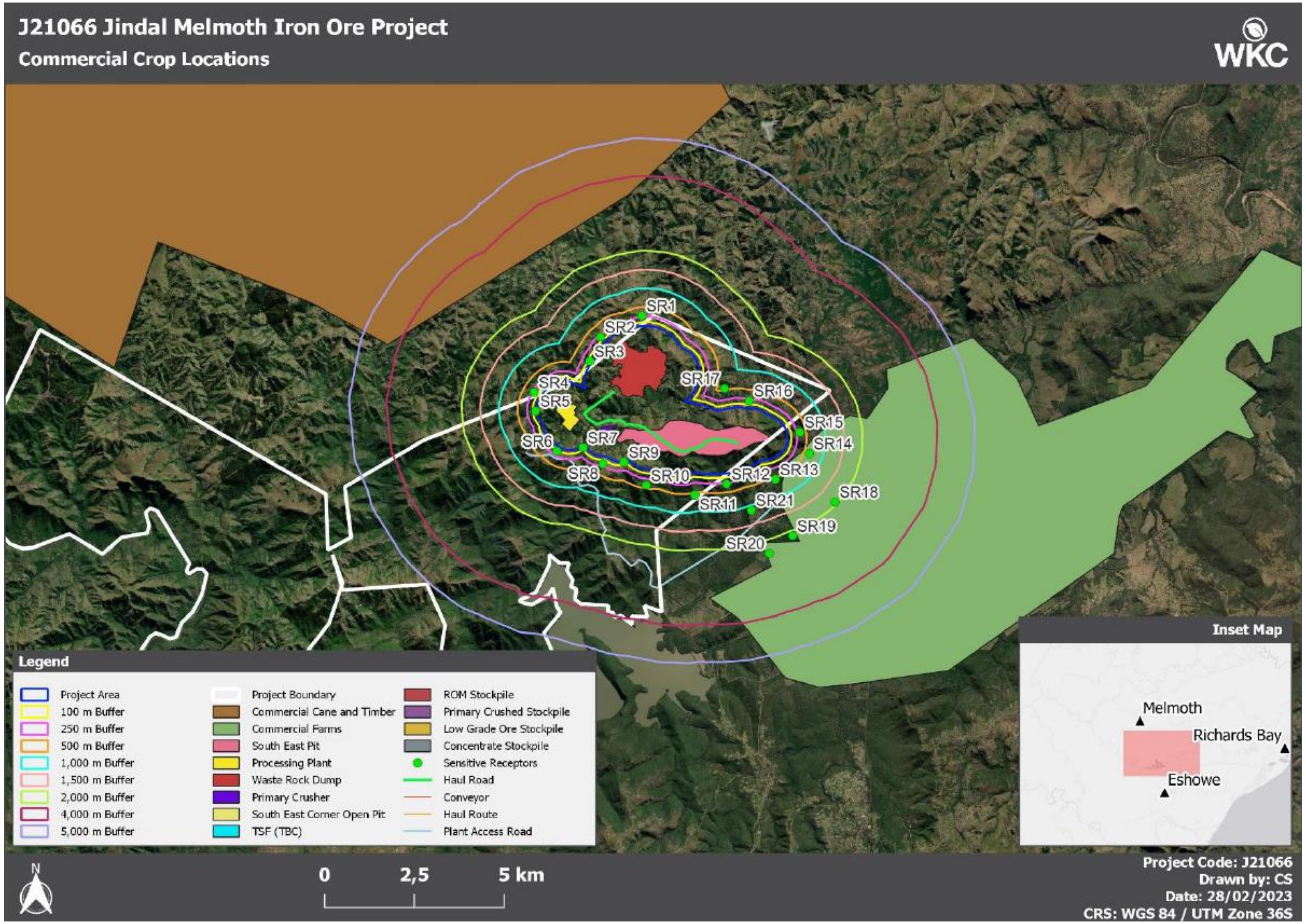


Table 7-7 – EIA Impact Assessment – Vegetation

Issue: Impacts to nearby commercial farms (cane, citrus, timber) as a result of dust fall out		
Phase: Operations Phase		
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Medium	Low
Duration	Long-term	Long-term
Extent	Regional	Regional
Consequence	Medium	Low
Probability	Possible	Possible
Significance	Low	Very Low
Degree to which impact can be reversed	Reversible, with the implementation of management measures.	
Degree to which impact may cause irreplaceable loss of resources	Unlikely, with the implementation of management action.	
The following mitigation actions are recommended	• Paving the main access road; • Preparation of a dust management plan as part of the Project EMPr; • Addition of surfactants and dust suppressants when watering; • Large trees and thick indigenous vegetation to be established along the Project boundary to reduce wind speeds and provide visual buffer between mining activities and community. Planting should commence well in advance of construction activities and should be informed by a dedicated Plan; • Reduce vehicle speeds to 30 km/hr or below on all internal haul routes and roads; • Utilise chutes at material handling transfer points; • Ensure vehicles carrying dry soil and other materials are covered during travel; and, • Cover the surface of haul routes with less erodible aggregate material such as compacted and treated crusher run / aggregate.	
The following monitoring is recommended	• Install at least two continuous analysers (for PM_{10} and $PM_{2.5}$) at the Project boundary (or at other suitable locations such as homesteads), one upwind and one downwind as proposed in Figure 7-1; • Install dust fallout gauges at a minimum of 8 locations (principal wind directions) as proposed in Figure 7-2, with monitoring commencing at least one year before the construction commences; and, • Implement a community complaints / grievance mechanism.	

7.2.3 Impacts from Blasting Activities

Blasting activities have the potential to generate gaseous pollutants NO_x and CO from the blast emulsion (explosive type), as well as TSP and PM_{10} from the blasting of the ore body. Based on the blast emission inventory, the total suspended particulate, PM_{10} and $PM_{2.5}$ equates to roughly the following (assuming a blast area of 4,000 m^2 and the NPI emission factor of 0.0002 kg/m^2 (TSP) [11]):

- TSP: 55.7 kg/blast
- PM_{10}: 29.5 kg/blast
- $PM_{2.5}$: 1.7 kg/ blast

Assessment of Potential Impacts

Dust movement in the atmosphere from blasting activity can be roughly divided into three stages:

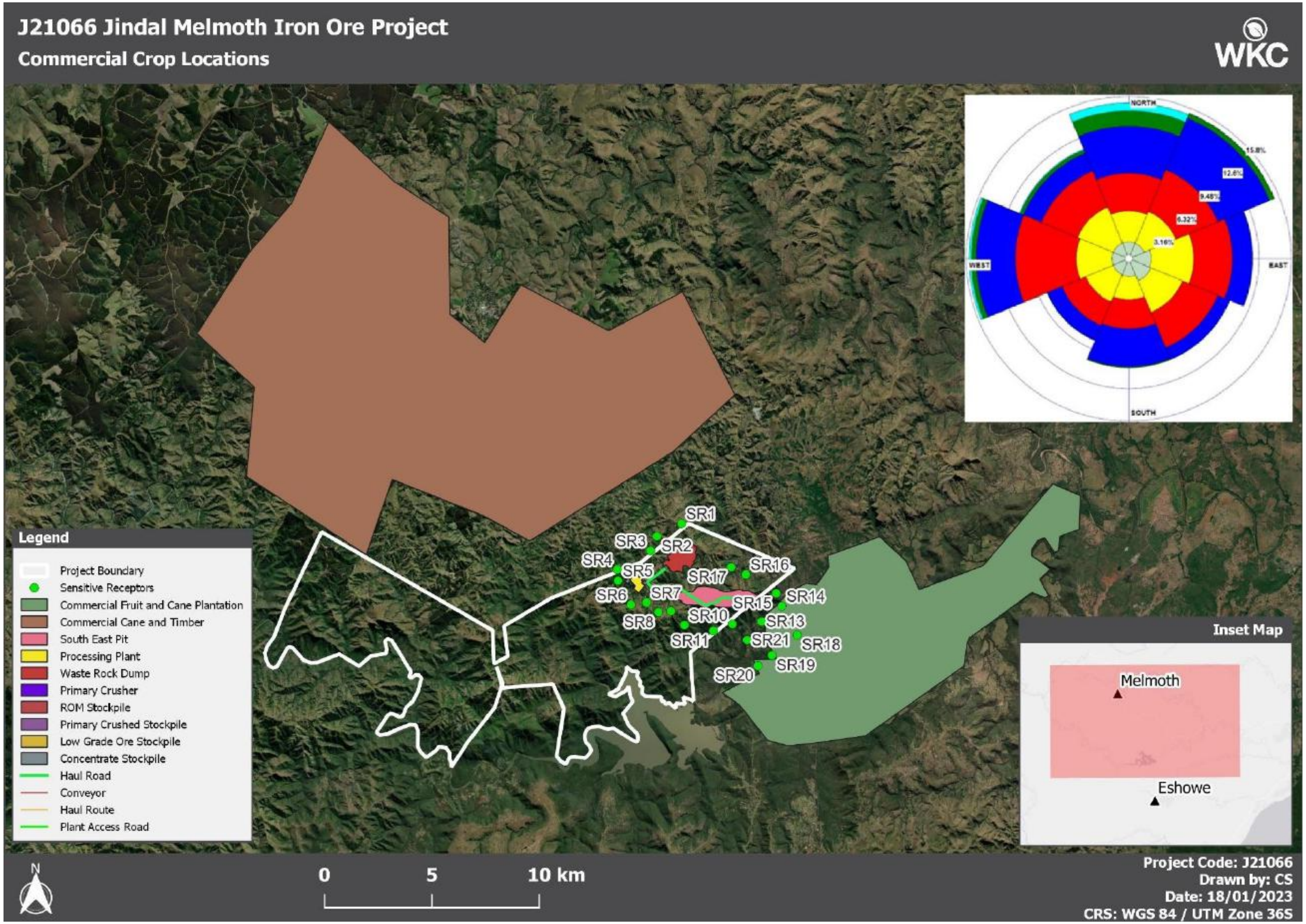
1. Impact movement stage;
2. Mushroom cloud formation stage; and,
3. Diffusion and deposition stage.

The extent and duration of the blasting events is relatively short lived, with a sequence of near instantaneous blasts within the block (up to 200 holes with charges), and in most cases with visible plume that dissipates after a few minutes.

Research suggests that almost all dust with a particle size of about 250 μm and greater will fall to the ground within 30 seconds under low wind speed conditions, whilst dust with a particle size of 60 – 100 μm settles more slowly. Dust with a particle size of below 40 μm stays airborne for the longest due to the strong disturbance by air flow and size fraction [12].

Regarding impacts to agricultural activities, the nearest fields (citrus, cane and other edible crops) are located at the closest approximately 1 km away to the east and south east of the pit. The nearest commercial forestry is located approximately 3 km to the north west of the pit (refer Figure 7-4). As blasting will only take place during the day time, a day time annual wind rose has been superimposed on the image below. The most frequent winds during the day blow from the direction of the commercial fruit and cane plantations towards the pit (away from the crops). The key wind vectors likely to blow in the direction of the commercial farms are from the west and north west. If the larger diameter particles (> 250 μm) are likely to settle within 30 seconds of the blast, with a 5m/s wind speed, larger particles are likely to deposit within 150 m from the blast (300 m for a 10 m/s wind speed). Smaller particles are likely to travel further, however, smaller particles are less of a concern in terms of deposition and soiling. It is reasonable to assume that with the implementation of specific blast control measures (modern, electronic, sequential blast techniques with adequate stemming), particles that are likely to cause dust deposition concerns for agriculture will have limited potential for impact given the distance to the nearest fields / crops. In addition, once the blasting reaches sub ground levels (i.e., in the pit) there will be additional control provided by the pit walls.

Figure 7-4 Commercial Plantations and Crops



In terms of long-term health impacts from finer particles, the blasting is likely to take place twice a week (same day), and the actual event will be short lived (less than 5 minutes visible plume per blast). Health impacts from PM arise from long term exposure, and as a result the NAAQS for PM are set for the 24 hour and annual averaging period. Therefore, given the short duration of the blast event, and infrequent nature of blasting (one day per week) blasting activities are unlikely to pose an impact to community health from finer particles. In addition, the mine blast impact report concluded that no receptors should be present within 500 m of the pit [13], which will allow sufficient diffusion and dispersion to occur.

Table 7-8 – EIA Impact Assessment – Blasting

Issue: Impacts to nearby agriculture and receptors from dust fallout as a result of blasting		
Phase: Operations Phase		
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Medium	Low
Duration	Very Short Term	Very Short Term
Extent	Local	Local
Consequence	Medium	Low
Probability	Probable	Probable
Significance	Medium	Low
Degree to which impact can be reversed	The impacts are reversable with the implementation of mitigation measures, or ceasing of activities	
Degree to which impact may cause irreplaceable loss of resources	Unlikely, with the implementation of management action.	

The following mitigation actions are recommended [13]	• Evacuate people and animals out of the danger zone prior to any blasting taking place (blast safety recommendation is 500m).
	• It is recommended that a standard blasting time is fixed and blasting notice boards setup at various routes around the project area that will inform the community of blasting dates and times, in addition to social media postings.
	• Undertake initial test blast and monitoring downwind to define blasting operations going forward. This test blast can be based on the existing design and after this blast it may be necessary to define if design changes are required or not.
	• Monitoring during the test phase should include a continuous ambient air quality analyser capable of measurement of PM_{10}, $PM_{2.5}$, NO_2 and CO. The analyser should be located downwind of the blast, at the boundary of the danger zone. Once the test blasting is complete and the proponent has demonstrated that concentrations of these pollutants are below the corresponding standard, this requirement can be removed and replaced by the long term monitoring campaign (see monitoring section).
	• Recommended stemming length should range between 25 and 30 times the blast hole diameter. In cases for strict fly rock control this should range between 30 and 34 times the blast holes diameter.
	• Video footage of each blast will help to define if excessive fly rock and dust plumes occurred and the origin. Immediate mitigation measures can then be applied if necessary. The video will also be a record of blast conditions in case of complaints
	• Meteorological conditions:
	  ◦ Blasting should only be undertaken during low winds speeds (< 5 m/s). No blasting should be undertaken where wind speeds are greater than 20m/s from a design safety perspective, however for dust dispersion purposes, 10m/s should be the maximum threshold.
	  ◦ Avoidance of blasting during winds from the West and South West will minimise potential impacts on agricultural receptors.
	  ◦ Avoid early morning blasting and late in the afternoon in winter when there is a possibility of atmospheric inversion.
	  ◦ Do not blast in fog, or low overcast clouds.
	  ◦ Do not blast in the dark (day time hours only).
	  ◦ Refrain from blasting when wind is blowing strongly in the direction of the closest nearby receptors
	  ◦ Watering or application of palliatives on the blast area following the charging of the blast holes with explosives is recommended where feasible.	

The following monitoring is recommended	• Install at least two continuous analyzers (for PM_{10} and $PM_{2.5}$) at the Project boundary (or at other suitable locations such as homesteads), one upwind and one downwind (Figure 7-1). Dates and times of blast activities should be recorded and monitoring data analysed to determine if an increase in PM_{10} and $PM_{2.5}$ levels occur during blasting. • Install dust fallout gauges at a minimum of 8 locations (principal wind directions) as proposed in Figure 7-2, with monitoring commencing at least one year before the construction. The gauges need to cover both community and agricultural areas. • Implement a community complaints / grievance mechanism; and • Implement monthly/ quarterly feedback meetings with the nearby farming communities.	

8 Conclusions

8.1 Summary of Study Findings

An AQIA has been carried out for the Jindal Melmoth Iron Ore Mine. The focus of this ADM and AQIA were the south-eastern section of the South Block.

8.1.1 Baseline Air Quality

An ambient air quality baseline survey was conducted for dust fallout and PM at sensitive receptors located near the Project area. The dust fallout results were obtained over two one-month periods (Cycle 1 and Cycle 2) at seven locations. All seven dust fallout units showed values below with the applicable Dust Control Regulations [4] for Cycle 1. Similarly, Cycle 2 was the same [4], with exception of the sample collected at monitoring location DB 5, located at the Mxosheni Combined School Region. The month two values at this location were an order of magnitude higher than the other locations, which indicates a highly localised event (in proximity to the fallout gauge).

PM monitoring was undertaken using a single Osiris Real-time Particulate Analyser (monitoring station) which was set-up at the Ngobese Homestead. The monitoring results for PM_{10} showed no exceedances relative to the NAAQS [3] value of 75 µg/m^3. The monitoring results for $PM_{2.5}$ also showed no exceedances relative to the NAAQS [3] 24-hour standard of 40 µg/m^3. It was noted that the values are considered indicative of the period when sampling was undertaken, and are not technically comparable against the standards, however, the measured values do provide an indication of the surrounding airshed status.

Due to the scale and nature of activities in the vicinity of the Project site as well as the rural nature of the surrounding environment, the ambient air quality is considered to be reflective of a rural environment, not heavily influenced by anthropogenic background emission sources, with the key exception of agricultural activities (dust from exposed fields, roads and other activities such as seasonal burning of cane). This is reflected by the relatively low levels of dust fallout collected (i.e. below 600 mg/m^2/day).

8.1.2 Impact Assessment

Exceedances of the short term and long-term standards for both PM_{10} and $PM_{2.5}$ were also observed to be nearby to the haul routes and southeast pit as illustrated in Figure 6-1 to Figure 6-4. The ADM results for dust fall out indicated that areas in close proximity to the haul routes and southeast pit will experience the highest dust fallout rates, however, with design mitigation no exceedances of the dust fallout standards are predicted at the nearby SR's.

In terms of impacts to community health, when adopting the SLR assessment methodology, the following outcomes are predicted:

- Exceedance of the Short-term and/or Long-Term PM_{10} and $PM_{2.5}$ NAAQS at SR7, SR10 – SR17, SR19 and SR21 and the resultant impact on human health:

- **High** significance with the standard design mitigation, which is reduced to **Medium** significance with additional mitigation.

- Exceedance of the Short-term and/or Long-Term PM_{10} and $PM_{2.5}$ NAAQS at SR1-6, SR8, SR9, SR18 and SR20 and the resultant impact on human health:
  - **Medium** significance with the standard design mitigation, which is reduced to **Low** significance with additional mitigation.

Dust nuisance and impacts to nearby vegetation (cane, citrus) as a result of dust fall out:

- **Low** significance with the standard design mitigation, which is reduced to **Very Low** significance with additional mitigation.

The impact of dust on community health and vegetation as a result of blasting activities:

- **Medium** significance with the standard design mitigation, which is reduced to **Low** significance with additional mitigation.

Additional mitigation as outlined Appendix E are recommended for inclusion into the design basis (which includes a source apportionment component for key areas of focus).

8.2 Conclusion

The Project site is located in an area that is currently inhabited, and at this stage the extent of potential resettlement has not yet been established. It is expected that there will be resettlement associated with the Project which will increase the distance between the mine and the nearest sensitive receptors, thereby lowering potential impacts. Based on the findings in this report there are potential exceedances of the short-term AAQS in close proximity to the site, however, exceedances of the long-term standards are not predicted (with exception of SR7 at the entrance gate). In terms of impacts to community health, long term exposure to air pollution is of greater concern than short term exposure. Long term exceedances are not predicted at the bulk of the SR locations. When considering impacts to nearby agricultural activities (commercial and subsistence) from dust fallout, the model values suggest that the bulk of the TSP will settle in close proximity to the Project site (i.e., within the 500 m exclusion zone). Blasting activities are considered to have a temporary and localized effect on the environment.

Mitigation and monitoring measures as recommended in Section 7.3 should be implemented to reduce the dust emissions from the operations of the facility. The proposed location of continuous analysers and dust buckets presented in Figure 7-1 and Figure 7-2 are preliminary and subject to change based on design and layout changes. It is also recommended that a dust management plan be prepared as part of the Project-specific EMPr to include the adoption of best practices to control emissions from material handling, water and dust suppressant application and restriction of vehicle speeds among others proposed within this report. The monitoring recommendations should also be included within this document. An air quality and dust complaints / incident reporting procedure should be implemented as part of the community engagement and grievance mechanism for the surrounding communities to report any complaints to the relevant stakeholder / social engagement personnel. The analysis of the complaints received should aid in identifying and actioning more specific and appropriate mitigation or remediation measures.

Whilst air quality impacts should be considered together with social, economic, water and other environmental related considerations and not in isolation, when considering the minimum distance between the community and the mine (500m), and the mitigation measures that will be mandatory, no fatal flaws were identified from an air quality perspective.

9 References

[1] Holman et al, "IAQM Guidance on the assessment of dust from demolition and construction," Institute of Air Quality Management, London, 2014.

[2] Department of Environmental Affairs, Government Notice No. 37804, "National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004), Regulations Regarding Air Dispersion Modelling, Code of Practice for Air Dispersion Modelling in Air Quality Management in South Africa," 2014.

[3] Department of Environmental Affairs, "The National Environmental Management: Air Quality Act (Act No. 39 of 2004), Standards and Regulations," 2015.

[4] Department of Environmental Affairs, "The National Environmental Management: Air Quality Act (Act No. 39 of 2004), National Dust Control Regulations," 2013.

[5] Department of Environmental Affairs, ""Regulations Regarding Air Dispersion Modelling (Code of Practice), National Environmental Management: Air Quality Act," 2014.

[6] Air Impact measurement Specialists, "Annual Air Quality – 2020," Richards Bay Clean Air Association (RBCAA), Richards Bay, 2021.

[7] Airshed Planning Professionals, "Air Quality Impact Assessment for the South32 Mamatwan Mine Project," 2021.

[8] South Coast Air Quality Management District Governing Board, alifornia Emission Inventory Development and Reporting System, Final – Methodology to Calculate Particulate Matter (PM) and PM2.5 Significance Thresholds-Appendix A., 2006.

[9] Department of Environmental Affairs, Government Notice No. 37804, "National Environemntal Management: Air Quality Act, 2004 (Act No. 39 of 2004), Regulations Regarding Air Dispersion Modelling, Code of Practice for Air Dispersion Modelling in Air Quality Management in South Africa," 2014.

[10] United Kingdom Institute of Air Quality Management, , “Guidance on the Assessment of Dust from Demolition and Construction,” London, 2014.

[11] Australian Government: Department of Sustainability, Environment, Water, Population and Communities, “[12] Australian GovernmeNational Pollution Inventory: Emission Estimation Technique Manual for Mining, Version 3.1,” 2012.

[12] Huang, Z et al, “NUMERICAL SIMULATION OF BLASTING DUST POLLUTION IN OPEN PIT MINES,” *APPLIED ECOLOGY AND ENVIRONMENTAL RESEARCH ,* vol. 17(5), pp. 10313-10333, 2019.

[13] Blast Management and Consulting, “Blast Impact Assessment Proposed Jindal Melmoth Iron Ore Project,” 2022.

[14] US EPA Office of Air Quality Planning and Standards , “United States Environmental Protection Agency, AP 42, Fifth Edition, Volume 1, Chapter 13 – Miscellaneous Sources, Section 13.2.2 Unpaved Roads.,” 1995.

[15] C. Cowherd, G. E. Muleski and J. S. Kinsey, “Control of Open Fugitive Dust Sources: Final Report,” U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, 1988.

[16] R. Thompson and A. Visser, “Benchmarking and management of fugitive dust emissions from surface - mine haul roads,” *Mining Technology,* vol. 111:1, pp. 28-34, 2002.

[17] Katestone Environmental Pt Ltd, “NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining,” Katestone Environmental Pt Ltd, Queensland, 2011.

[18] T. Stevenson, “Recommended Practices and Best Available Control Measures Dust Suppressant Selection Guides - A Manual,” Industries of the Future Converse Area New Development, 2004.

[19] R. e. a. Flochhini, “Evaluation of the Emission of PM-10 Particulates from Unpaved Roads in the San Joaquin Valley,” University of California, Davis, 1994.

[20] R. J. Thompson and A. T. Visser, “The functional design of surface mine haul roads,” 2000.

[21] A. P. Professionals, “Air Quality Specialist Report for the Proposed Heuningkranz Project,” 218.

Appendix A – NEMA Regulations (2017), Appendix 6

NEMA Regulations (2017) – Appendix 6	Relevant section in report
Details of the specialist who prepared the report	Appendix B
The expertise of that person to compile a specialist report including a curriculum vitae	Appendix B
A declaration that the person is independent in a form as may be specified by the competent authority	Appendix B
An indication of the scope of, and the purpose for which, the report was prepared	Section 1.2.1: Study Objectives
An indication of the quality and age of base data used for the specialist report;	Section 3: Meteorological Data Section 4: Existing Ambient Air Quality
A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 7: Air Quality Impact Assessment
The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	Section 4: Ambient Impact Analysis and Ambient Levels
A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Section 5: Modelling Procedures
Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternative;	Section 5: Modelling Procedures
An identification of any areas to be avoided, including buffers	Section 5: Modelling Procedures
A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Section 5: Modelling Procedures
A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 5.2.3: Model Assumptions Section 5.2.4: Uncertainties
A description of the findings and potential implications of such findings on the impact of the proposed activity or activities	Section 8: Conclusions
Any mitigation measures for inclusion in the EMPr	Section 7: Air Quality Impact Assessment
Any conditions for inclusion in the environmental authorisation	N/A
Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 7: Air Quality Impact Assessment
A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	Section 8: Conclusions

NEMA Regulations (2017) – Appendix 6	Relevant section in report
Regarding the acceptability of the proposed activity or activities; and	Section 8: Conclusions
If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	Section 7: Air Quality Impact Assessment Appendix E
A description of any consultation process that was undertaken during the course of carrying out the study	N/A
A summary and copies if any comments that were received during any consultation process	N/A
Any other information requested by the competent authority.	N/A

Appendix B – Specialist CV and Declaration

PROFESSIONAL PROFILE

Marc Blanché

BSc. (Hons), MSc.

Partner

Marc is a Partner at WKC Group, an international consultancy that specialises in technical services and has particular focus on the oil and gas, power and mining industries. Marc has over 15 years' experience as an Environmental Scientist and is well versed in the environmental laws and regulations pertaining to the countries within which his projects are based. Marc currently manages WKC 's African operations comprising of engineers and scientists with a core focus on the delivery of technical studies across the Middle East and African continent.

Marc started his career as an Environmental Impact Assessment Practitioner in 2005 and began his specialisation as an Air Quality Consultant in 2008 for a well-known multinational company. In 2010, Marc joined WKC Group as an air quality specialist where he has primarily worked on Equator Principal Financial Institution (EPFI) compliant environmental assessments, with particular emphasis on the International Finance Corporation (IFC) Performance Standard 3 and the General Environmental, Health and Safety (EHS) Guidelines.

EDUCATION

- MSc. Applied Environmental Sciences (2005, 1st Class Cum Laude).
- BSc. (Hons) Applied Environmental Sciences (2002)

COUNTRIES OF WORK EXPERIENCE

United Arab Emirates, Oman, Iraq, Egypt, Libya, Jordan, Lebanon, Saudi Arabia, Qatar, Mozambique, Lesotho, Democratic Republic of Congo, Kenya, Tanzania, Namibia, Nigeria, Ghana, Zambia, Rwanda, and South Africa and South Korea

LANGUAGES

English, Afrikaans and basic isiZulu

CAREER SUMMARY

- 2015 onwards
  Partner, WKC Group
- 2012 – 2015
  Principal Consultant, WKC Group
- 2010 – 2012
  Senior Consultant, WKC Group
- 2008 – 2009
  Air Quality Consultant, WSP Environment and Energy
- 2006 – 2008
  Environmental Consultant, Knight Piésold Consulting
- 2005 – 2006
  Construction Projects Manager (Environmental), JB Projects

FIELDS OF SPECIAL COMPETENCE

- Air Quality Impact Assessment

- Carbon Foot-printing (World Resources Institute)
- EIA / HSEIA for International Oil, Gas and Power Developments
- Atmospheric Dispersion Modelling and Screening Assessments (AERMOD, Screen 3, ADMS, DMRB, Caline 4)
- Ambient Air and Noise Monitoring
- Geographical Information Systems (ArcGIS)
- Impact Assessment for Bank Financed Projects

POST NOMINAL TITLES

- Pr Sci Nat. Awarded post-nominal title of Professional Natural Scientist (Pr Sci Nat) in terms of Section 20(3) of the Natural Scientific Professions Act, 2003 as regulated by the South African Council for Natural Scientific Professions
- MIEnvSci. Awarded membership to the UK Institution of Environmental Sciences
- MIAQM Awarded membership to the UK Institution of Air Quality Management

KEY EXPERIENCE

Air Quality

- Afrisam Cement – Coedmore, Durban, South Africa – Dust Monitoring and Management – Project managed both the field work and reporting component for the ongoing dust impact study for the Afrisam Coedmore quarry. Dust deposition gauges were deployed on-site as well as at a number of locations within the surrounding community. Results were collected and then presented as a series of monthly reports, with one larger annual report.
- Afrisam/NPC Cimpor Cement– Coedmore Source Apportionment Study – Was part of a joint venture team undertaking a source apportionment study of PM10 and fallout dust for Coedmore Park Area (South Africa). Two neighbouring companies needed to establish their relevant contributions to ambient dust in the vicinity of their premises. This was undertaken by deploying fallout gauges and then performing various analyses on the samples to determine the mineral content and apportionment (as the two companies made use of different materials). The results were presented on a GIS output grid in order to display the relevant distribution from source.
- Cement Grinding Facility, Coega, South Africa. Marc led the air quality impact assessment for the cement grinding and blending facility located in the Coega Industrial Zone. The study included emission inventory development and modelling of both the cement plant and all other non-project related emission sources within the Port Elizabeth area.
- Project Manager for the Air Dispersion Modelling component of the concept/ pre-FEED ESIA Ruwais Derivatives Park – Involved the preparation of an ADM inventory for multiple world-scale petrochemical production units and undertook project management for the Project – 2021 [ADNOC/ UAE]
- Project Manager AMIC ilmenite smelting facility, Jazzan, KSA – 2021. Marc managed the successful delivery of an air dispersion modelling assessment for a world-scale ilmenite smelting facility with a specialised focus on dust emissions through the handling and processing of titania slag.
- Lead external review of the client confidential Nuclear Power Station ESIA (including air quality chapters), Kingdom of Saudi Arabia -2021
- Globaleq 1,500 MW power plant, Saldanha, RSA – 2021. Marc managed the delivery of an air dispersion modelling assessment for a 1,500 MW closed-cycle gas turbine generator (CCGT) power plant in Saldanha, South Africa.
- Blue Crane Funerals Crematorium, Strand, RSA – 2021. Marc managed the successful delivery of an urban crematorium facility for the appropriate destruction of human remains.
- GCCIA Iraq / Kuwait Interconnection, Iraq / Kuwait – 2021. Marc managed the air quality component for inclusion into detailed lender ESIA for the construction of a 400kV overhead transmission line commissioned by the Gulf Cooperation Council Interconnection Authority.
- Diriyah Gate Development Project, KSA – 2021. Marc managed the overall quality of deliverables for the traffic air quality impact assessment focussed on both construction and long-term operation for the vehicle traffic network in and surrounding the Diriyah Gate Development project, a prestigious project celebrating rich KSA cultural elements with residential, commercial and mixed use components.
- Fujairah 3 Power Project, UAE – 2020. Marc led the air dispersion, GHG and noise modelling studies for the F3 Project which includes a 2.4 GW gas fired combined cycle power plant. The studies were undertaken using US EPA CALPUFF modelling suites in accordance with lender requirements.
- Etihad Rail Project, UAE – 2019/2020. Marc performed the final review and sign off for the air dispersion modelling studies undertaken for the Etihad Rail Project which included an assessment of diesel locomotives across various sections including Stage 2, Stage 3A, 3B, and 3C. The assessment included the air dispersion modelling and noise modelling of the proposed rail network stretching across the UAE from the Saudi Arabian border to Oman in the east, and to the north of the UAE across the emirates of Abu Dhabi, Dubai, Sharjah, Umm Al-Quwain, Fujairah, and Ras Al Khaimah.
- Hudayriyat Island West Project, UAE-2020. Marc Project managed the air dispersion modelling study for the Hudayriyat Leisure and Recreation District Project to be located on Hudayriyat Island. Pollutant emissions from road traffic associated with the proposed development were modelled within the US EPA AERMOD model. KEY EXPERIENCE (Continued)
- Jebel Hafeet Development, UAE – 2018. Marc led the air dispersion modelling study associated with road traffic emissions for the Jebel Hafeet Development.
- JPRC Fourth Refinery Expansion Project, Jordan – 2019. Marc led the delivery of a refinery wide air dispersion model using US EPA CALPUFF. The study incorporated in excess of 40 point sources within a 100 x 100 km model domain undertaken in accordance with lender requirements.
- Atmospheric Dispersion Modelling, Shams Power Station, UAE – Undertook the atmospheric dispersion modelling and stack optimisation for the Shams Solar Power Plant booster heaters. The Shams solar power station is a planned concentrating solar powered station in Madinat Zayed, Abu Dhabi. The first part, Shams 1, will have a capacity of 100-125(MW), which at the time made it the largest parabolic trough power station in the world, and a flagship project within the UAE.
- DEWA Power Station, UAE – 2015. Marc formed part of a team that compiled an emission inventory and undertook Atmospheric Dispersion Modelling using AERMOD for the 2,000 MW DEWA power station in Dubai.

- GASCO 4th NGL Train, Abu Dhabi – 2011. Formed part of a technical team that worked closely with the EPC design team based in Seoul, South Korea, where an extensive EIA was undertaken for GASCO's expansion to their existing gas processing facility in Abu Dhabi's Ruwais Industrial City.
- GASCO Habshan 5 Gas Processing Facility, Abu Dhabi – 2010. Worked with a multi-disciplinary design team based in Japan, South Korea and Italy. WKC undertook an EIA for the permitting of a $5 billion Greenfield project in Abu Dhabi. Assisted with the establishing impacts to air quality from major combustion equipment including the Sulphur Recovery Units. Also undertook dispersion modelling of the worker camp power generators in order to establish the air quality impacts to the 15,000 man worker camp.
- AMIC Ilmenite Titanium Slag Smelter Jazzan Economic City (JEC), Saudi Arabia – 2020. Marc Project managed the delivery of an air dispersion modelling study for the AMIC facility using US EPA CALPUFF. Emission sources include the furnaces, dust filters, and material handling activities.
- Somkhele Coal Mine, South Africa – 2019/2020. Marc Project managed the delivery of the air quality and noise impact assessments associated with three new coal mining pits located in Northern KwaZulu-Natal.
- Jazzan Economic City, Saudi Arabia – 2016. Marc led the city wide regional scale, detailed modelling assessment of JEC utilising the US EPA regulatory dispersion model, CALPUFF. The study incorporated in excess of 170 point sources in addition to area and line sources located within a 128 x 128 km model domain. The aim of the assessment was to determine, in principle, whether the industrial city can be developed in such a way that air quality impacts to community health and the environment can be avoided, acknowledging:
  - The range of industrial tenants (existing, proposed and currently undefined);
  - The regulatory framework within which existing and future tenants will be regulated;
  - The intensity and distribution of road traffic;
  - The prevailing meteorological conditions; and
  - The orientation of City zoning with regards to residential and other ecologically sensitive areas.
- Al Ghabawi Landfill Jordan- 2018. Marc led the delivery of the air dispersion modelling study for Jordan's largest landfill in order to fulfil EBRD requirements. The study included both emissions from the landfill gas engines, as well as odour emissions and dust from the landfilling activities.
- Project Manager for the Brass Liquefied Natural Gas (LNG) Facility Air Quality and Noise Impact Assessments, Delta State Nigeria– 2013. The Project has a reputed capital value of over 20 Billion US dollars and will entail a two train 10 million metric tonne per year facility.
- Project Manager for the Maputo Port Upgrade Project, Mozambique– 2014, which entailed baseline data collection (air quality and noise) and predictive modelling (air quality and noise) for future port expansion plans to the year 2030. In addition, the project included a detailed dust management plan for bulk handing operations.
- Project Manager for the Zambese Coal Mine Project (Mozambique– 2017), this project entailed air quality and noise baseline data collection, predictive modelling of mining related impacts (air quality and noise), and associated impact assessment.
- Project Manager for the Machipanda Railway (Mozambique– 2016) Air Quality and Noise Scoping Phase Assessments
- Project Manager for the Shell Bonga South West / Aparo Field Development Project, Nigeria– 2016. Undertook dispersion modelling and impact assessment of the Floating Production, Storage and Offloading (FPSO) unit as part of the ESIA.
- Project Manager for the Aje Field Development Plan, offshore Lagos, Nigeria. Undertook air dispersion modeling and impact assessment for the FPSO unit and offshore assets as part of the ESIAProject Manager for the Okoro Full Field Development Offshore Nigeria. Managed the team that undertook the air dispersion modelling and impact assessment for the mobile offshore production unit (MOPU) – 2015.
- Natref Clean Fuels II Project South Africa – 2012. Project Managed the NATREF Clean Fuels II Project which entailed a refinery wide Air Dispersion Model and air quality impact assessment.
- Abu Dhabi Dubai Highway Project – 2011. Undertook the Construction and Operation Phase Air Quality Impact Assessment Using USEPA AERMOD and Caline 4 Roads model.
- Project Manager for the Common Seawater Supply Project (CSSP), Iraq. – 2015. Project managed the air quality, noise and soil and groundwater modelling studies for the CSSP. The Project entailed power generation (10 large turbines, 6 diesel generators), pumping stations, water treatment facilities, and a pipeline network designed to supply the giant oil fields of West Qurna-1, West Qurna-2, Zubair, Majoon, Missan, Rumaila, Halfaya, Gharraf and other normal fields (southern Iraq). The CSSP has the capacity to supply 2.5 million barrels of water per day for reinjection purposes.
- Shell Majnoon Early Production Phase Project Iraq – 2014. Project Manager. Undertook the emission inventory and air dispersion modelling for the Oil and Gas Phases of the Shell Majnoon Early Production Project in Iraq. This included modelling of the entire Central Processing Facility, Gas Processing Plant and remote stations DS1 and DS2. The first commercial production will produce 175,000 barrels of oil per day.
- Air Quality and Noise Impact Assessment, Dutwa, Tanzania – 2015.Project Managed the air quality and noise impact assessment for the Dutwa Nickel Mine in Tanzania which will cost approximately US $600 million to develop and will constitute one of the largest mines in the region. The project included baseline surveys, predictive modeling and impact assessment.
- Atmospheric Dispersion Modelling, Empangeni, South Africa – 2012. Project managed the Atmospheric dispersion modelling of a proposed sludge tailings facility for Exxaro Mines in Empangeni, South Africa. Project task included emission inventory development, dispersion modelling of PM_{10} and dust fallout.
- PetroChina Halfaya Central Processing Facilities Iraq– 2014. Undertook Atmospheric Dispersion Modelling for the PetroChina Halfaya Oil Central processing facilities (CPF 1 and CPF 2).
- Atmospheric Dispersion Modelling, Dolphin Gas Plant Ras Laffan, Qatar – 2011. Undertook the atmospheric dispersion modelling for the Dolphin Gas Processing and Production Plant Upgrade in Qatar. The project included the assessment of three (52 MW) additional Rolls Royce compression turbines in the context of existing plant operations. The plant is the single largest gas processing plant in the world.
- Atmospheric Dispersion Modelling, Shams Power Station, UAE – 2012. Undertook the atmospheric dispersion modelling and stack optimisation for the Shams Solar Power Plant booster heaters. The Shams solar power station is a planned concentrating solar powered station in Madinat Zayed, Abu Dhabi. The first part, Shams 1, will have a capacity of 100-125(MW), which at the time made it the largest parabolic trough power station in the world, and a flagship project within the UAE.
- Atmospheric Dispersion Modelling, Cement Quarry, Saudi Arabia – 2012. Undertook the atmospheric dispersion model for a proposed cement quarry and crushing plant in Saudi Arabia. Key emission sources include the transport network, crushers, stockpiles and quarrying equipment and vehicles.
- AQIA for the Proposed Veterinary Incinerator, Canelands, South Africa – 2010. Undertook the AQIA for a proposed veterinary incinerator, located in close proximity to the King Shaka International Airport. Key aspects included a baseline air quality assessment, and atmospheric dispersion modelling of the proposed incinerator.

- NEM: AQA Training to the Cape Winelands District Municipality, South Africa – 2012. WKC were contracted to the Cape Winelands District Municipality to provide training to staff members on the implementation of the new Air Quality Act (AQA). Topics include an overview of the AQA, Atmospheric Emission Licensing (AEL's) and a breakdown of the relevant penalties and offences.
- Northern Aqueduct Pipeline, eThekwini Municipality, South Africa – 2013. Project Managed the Scoping and EIA phase of the Dust and Noise Specialist Studies for the Northern Aqueduct Pipeline in Durban, Kwazulu-Natal. The project included classifying approximately 80km of >1.5m diameter pipeline according to the various air quality and noise impacts associated with the development. The EIA phase investigation included undertaking construction dust and noise screening models at the key sensitive receptors.
- Saiwan Phase II Block Development, Oman – 2014. Undertook the Atmospheric Dispersion Modelling, GHG Study, Air Quality Management Plans and GHG and ODS Reduction Plan for two new in field oil production facilities in Saiwan and Farha, Oman.

ESIA

- Marc was the Project Management and Lead author for the JPRC Refinery 4th Expansion Project ESIA – 2019. The refinery is being expanded to increase its capacity from the existing 60,000 barrels per day (bpd) to 120,000 barrels per day in order to meet the needs of the Jordanian market for high-value products. The expansion plan will also make way for the refinery to upgrade its fuel quality to the Euro V emission standards. Marc led the delivery of the ESIA in accordance with international lender requirements
- Zallaf EPF EIA, Libya – 2020. Zallaf intends to develop NC200 oil field and at an early stage of the development the company will initiate install and operate an Early Production Facility (EPF), Oil Supply wells, water wells and other associated facilities associated with the development of the EPF. Marc led the delivery of the EIA and specialist studies.
- ADMA-OPCO Umm Lulu Field Development, UAE– 2010- An EIA was undertaken for the first phase of the development of the Umm Lulu offshore field in the Arabian Gulf. Key issues included impacts to air quality from flaring, disturbance to marine ecology from infield and trans-field pipelines and drilling activities.
- ZADCO New Main Oil Line, UAE – 2012. Assisted with an EIA for a new 30km crude oil line between the production field and an oil and gas infrastructure island in the Arabian Gulf. Key issues included disturbance to offshore, near shore and onshore ecosystems.
- Western Aqueduct, eThekwini Municipality, South Africa – 2006. Assistant consultant for the Public Participation, Scoping and Environmental Impact Assessment processes associated with a 73km bulk water pipeline (1.6m in diameter). Responsibilities included the design of an appropriate methodology to deal with the variety of biophysical and socio-economic environments along the route, the coordination of four renowned specialist teams, the public consultation with all interested and affected parties; government departments; stakeholders and interest groups, the liaison between the engineering design team; the client and the specialist teams, and the compilation of the relevant reports; documents and correspondence. In addition to the EIA, Marc assisted with the design and compilation the EMP which outlined the roles and responsibilities of the Project Team for the construction and operation of the pipeline.
- Clansthal Reservoir and Pipeline Project, KZN South Coast, South Africa – 2007. Supervised the Basic Assessment Process and associated Public Participation Process for a reservoir and pipeline project linking bulk water infrastructure to a local Municipality.
- Queensburgh Sewer Reticulation Project, Durban, South Africa – 2007. Supervised the Basic Assessment Process and associated Public Participation Process for a sewer reticulation system traversing important conservation corridors recognised by D'MOSS.
- Westville North Sewer Reticulation Project, Durban, South Africa – 2007. Supervised the Basic Assessment Process and associated Public Participation Process for a sewer reticulation system traversing urban stream environments.
- School access road upgrade project, Umzumbe, South Africa -2006, Supervised the Basic Assessment Process and associated Public Participation Process for an access road linking rural schools with local communities.
- Main Road P100 Upgrade, Ndwedwe, South Africa - 2009. Undertook the Environmental Scoping Investigations and Public Participation Process, and developed the EMP for the construction and upgrade of the P100 Main Road in Ndwedwe, KwaZulu-Natal. This project was an ARRUP initiative promoting development within a rural community. Also co-managed the associated Specialist investigations and compiled the environmental reports.

Noise Assessments

- Project Manager for the Northern Aqueduct bulk water supply project Air Quality and Noise Impact assessments, eThekwini Municipality, South Africa- 2015.
- Project Manager for the Niger River Second Bridge Noise Impact Assessment, Nigeria- 2015
- Project Manager for the Kinnagop Windfarm Noise Impact Assessment Lender Review Study, Tanzania- 2015.
- King Shaka International Airport (KSIA), Durban – 2011. Part of a team of specialists appointed by the KSIA to undertake noise verification sampling at specific receptor points in the vicinity of the new airport.
- Sonae Novoboard, White River – Noise Compliance Assessment – 2009. Undertook the annual noise compliance assessment at the Sonae Novoboard White River Plant. The study entailed taking both day and night time (baseline and operational) noise measurements at various fenceline and community sites around the facility within the SANS guidelines.
- Dolphin Coast Landfilll, KwaDukuza – Noise Impact Assessment – 2009. The study provided insight into any potential noise impacts associated with the existing facility, as well as an indication of potential impacts from proposed new noise sources. Predictive noise modelling was undertaken to assess the potential impacts associated with the expected increase in heavy vehicle traffic and volume of waste handled at the landfill.

PROFESSIONAL PROFILE

Shazelle Vinette James

BSc. Eng. Chem. Eng.

Environmental Consultant

Shazelle James is a Chemical Engineer (BSc. Chemical Engineering) by background with more than three years of experience in the environmental field. She is involved in projects which include; preparation of environmental impact assessments (EIAs) and permitting application packages (PAPs), inventory development, air dispersion modelling, odour assessments, greenhouse gas assessments and baseline air quality monitoring. Shazelle also has experience in noise modelling and baseline noise monitoring as well as Flow Induced Vibration (FIV) studies. Her area of expertise is considered to lie within air quality and EIA and PAP, ranging from oil and gas and masterplan projects in the Middle East to mines in Mozambique and South Africa with special focus on a wide range of projects within Saudi Arabia. She has undertaken large scale projects on a national and international scale. Shazelle has an excellent understanding of the local and international environmental legislature applicable to projects of any nature. Shazelle also holds a professional membership with the National Association for Clean Air (NACA) in South Africa.EDUCATION

- BSc: Chemical Engineering (University of KwaZulu Natal), 2017

REGIONS OF WORK EXPERIENCE

Africa: South Africa, Rwanda, Mozambique, DRC
Asia: Dubai, Abu Dhabi, Fujaira, Jordan, Kingdom of Saudi Arabia

LANGUAGES

English (Native), Afrikaans (Proficient), isiZulu (Basic)

CAREER SUMMARY

- December 2021 – Present
- Environmental Consultant, WKC Group
- May 2019 – December 2021
  Environmental Engineer, WKC Group
- August 2018 – May 2019
  Graduate Environmental Engineer, WKC Group

FIELDS OF SPECIAL COMPETENCE

- Environmental Impact Assessment (EIA)
- Air Quality Modelling and Impact Assessment (AERMOD, CALPUFF, SCREEN3)
- Permit Application Package (PAP)
- Air Emission License (AEL)
- Baseline Air and Noise Surveys
- Greenhouse Gas Emissions Inventory Preparation
- Odour Assessment (LandGEM)
- Environmental Management Plans (CEMPs)

KEY EXPERIENCE

Environmental Impact Assessment

-
- Hudayriyat Island West, Abu Dhabi, UAE.
  Shazelle prepared the Terms of Reference (ToR) report in addition to preparing multiple chapters withing the EIA. Shazelle was involved in the permitting process and authority submisisons.
- Farabi Linear Alkyl Benzen 4 (LAB#4) Expansion Project, Yanbu, Kingdom of Saudi Arabia.
  Shazelle managed as well as assisted the team that prepared the EIA required for an EPC along with other technical deliverables to meet RCER-2015.
- Diriyah Gate 2 EIA, Diriyah, Kingdom of Saudi Arabia.
  Shazelle prepared multiple chapters for the EIA as well as being involved with client communications and progress meetings associated with the EIA and permitting process.
- Ingenia Polymers Carbon Black Project, Jubail, Kingdom of Saudi Arabia.
  Assisted with the preparation of EIA chapters.

- Marafiq IWTP-8 Stage 4 Expansion, Jubail, Kingdom of Saudi Arabia.
  Shazelle assisted with the preparation of the EIA report as well as progress reports and communications with the client.
- Ruwais iRAMP Project, UAE
  Assisted in the preparation of chapters for the overall EIA report (construction and operations).
- Diriyah Gate Development (Samhan, Bujairi and Wadi Hanifah Districts) EIA, Diriyah, Kingdom of Saudi Arabia.
  Assisted in the preparation of chapters for the overall EIA report
- Propane Dehydrogenation and Polypropylene Project, Jubail, Kingdom of Saudi Arabia
  Assisted with preparation of the EIA.
- Hudayriyat Leisure and Recreation District, Abu Dhabi, UAE.
  Assisted in the preparation of the Hudayriyate Leisure and Recreation District EIA and supporting documents.
- Jordan Petroleum Refinery Company, Jordan
  Assisted in the preparation and compilation of the EIA for the proposed fourth expansion project for the Jordan Refinery. Undertook the project description, air quality and construction phase assessment sections within the EIA.

Noise

- Al Sadr Development, Abu Dhabi, UAE.
  Road noise assessment based on the increased traffic due to the Al Sadr Development.
- Amazon Data Centres Noise Study, Dubai and Abu Dhabi, UAE.
  Noise Study to assess the noise generated by the back-up generators and normal operating equipment at three proposed data centres in the UAE.
- Marjan Package 1 FIV, Kingdom of Saudi Arabia
  A Flow Induced Vibration (FIV) assessment conducted on the pipeline network for Marjan Package 1.
- TC Smelters Noise Screening Study, South Africa
  A noise screening study was undertaken to determine the impacts related to the proposed tailings storage facility.

Air Quality

- Ingenia Polymers Carbon Black Project, Jubail, Kingdom of Saudi Arabia.
  Shazelle carried out the air dispersion modelling study for the Ingenia Polymers facility.
- PRAXOS Umlazi Pyrolysis Plant AQIA and AEL, South Africa.
  Shazelle managed the successful completion of the AQIA and AEL application for a proposed pyrolysis facility in Umlazi, South Africa.
- Zambese Coal Mine Dust Modelling, Tete, Mozambique.
  Dust modelling study for the Zambese Coal Mine was undertaken to assess the potential impacts to the ambient air quality at a multitude of sensitive receptors.
- Consol Glass Air, South Africa.
  Plans of Study for the Wadeville and Clayville plants in connection with the Air Emissions Licence submission.
- Jordan Landfill, Jordan.
  Air dispersion modelling study for the Jordan Landfill to assess the ambient air quality impacts of the emissions from the burning of landfill gas as well as from the fugitive emissions emitted from the landfill. LandGem was used to determine the fugitive emissions.Lake Kivu Power Plant, Rwanda.
  Air Dispersion Modelling for a combine sack at the propose Lake Kivu Power Plant. The project involved the extraction of methane from below the surface of the lake that would be burnt at an onshore facility to generate electricity. Dubai Waste to Energy Surveys, Dubai, UAE.
  Air Dispersion Modelling study for the facility to verify GHG's Air Dispersion Modelling results and change of report format.
- Hail and Ghasha Onshore and Offshore Facilities, UAE.
  Air Emissions Modelling. Air dispersion modelling for onshore and offshore facilities.
- NEOM Silver Beach Development, Kingdom of Saudi Arabia.
  Air dispersion modelling study for the gas turbines to be used for back-up power generation.
- Belbazem Block Field Development ADM, Abu Dhabi.
  Air dispersion modelling study for the heaters, turbines and flares located within the Belbazem Block field Development.Maseko Piggery Odour Study, South Africa.
  Odour study for the proposed Maseko Family Trust Piggery Project.KEY EXPERIENCE (Continued)
- Fujairah 3 Power Plant ADM, Fujairah, UAE.
  Air dispersion modelling study for the gas powered, combined cycle turbines at the 2 400 MW Fujairah 3 Power Plant.
- Mutanda Mining Copper-Cobalt Plant, Katanga Province, DRC
  Assisted with the preparation of the air dispersion model
- Propane Dehydrogenation and Polypropylene Project, Jubail, Kingdom of Saudi Arabia
  Shazelle undertook the air dispersion modelling study and impact assessment for the facility.
- TC Smelters Air Screening Study, South Africa
  A air quality screening study was undertaken to determine the impacts related to the proposed tailings storage facility.
- Jindal Melmoth Iron Ore Mine, South Africa.
  Shazelle managed the preparation of the air dispersion modelling study and respective EIA chapter.

Permitting Applications Pacakage

- Farabi Linear Alkyl Benzen 4 (LAB#4) Expansion Project, Yanbu, Kingdom of Saudi Arabia.
  Shazelle managed the team that prepared, as well as assisted, in the PAP for EPC along with other technical deliveries to meet RCER-2015 requirements.
- Propane Dehydrogenation and Polypropylene Project, Jubail, Kingdom of Saudi Arabia
  Shazelle assisted in preparing the PAP for EPC to meet RC requirements.
- Marafiq IWTP-8 Stage 4 Expansion, Jubail, Kingdom of Saudi Arabia.
  Shazelle was responsible for completing multiple forms within the PAP.

- Ingenia Polymers Carbon Black Project, Jubail, Kingdom of Saudi Arabia.
  Shazelle reviewed the air series forms for the client prepared PAP pursuant of an EPC.

Marine

- Al Nasr Dubai Creek Harbour Monitoring, Dubai, UAE. Marine monitoring data capture and results reporting.

Survey / Onsite Works

- Jordan Petroleum Refinery Company, Jordan.
  Shazelle undertook a baseline survey to collect noise and air quality baseline data in the areas surrounding the Project. Diffusion tubes were deployed at various sites to assess the baseline air quality.
- GIBB Newlyn Diesel Storage Facility, South Africa.
  Conducted the baseline ambient air quality survey by means of deployment and collection of diffusions tubes.
- Kinservere Copper Mine, Lubumbashi, Democratic Republic on Congo.
  Shazelle conducted a dust and noise monitoring survey as part of the continuous monitoring campaign carried out by the Project owner. Noise measurements were taken at various location in and around the concession area and a dust monitor was deployed at various locations around the mine.

DECLARATION OF INTEREST BY SPECIALIST

KWAZULU-NATAL PROVINCE
ECONOMIC DEVELOPMENT, TOURISM AND ENVIRONMENTAL AFFAIRS
REPUBLIC OF SOUTH AFRICA

	(For official use only)
Provincial Reference Number:	
NEAS Reference Number:	KZN / EIA /
Waste Management Licence Number (if applicable):	
Date Received by Department:	

DETAILS OF SPECIALIST AND DECLARATION OF INTEREST

Submitted in terms of section 24(2) of the National Environmental Management Act, 1998 (Act No. 107 of 1998) or for a waste management licence in terms of section 20(b) of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008).

KINDLY NOTE:

1. This form is current as of **May 2021**. It is the responsibility of the Applicant / Environmental Assessment Practitioner ("EAP") to ascertain whether subsequent versions of the form have been released by the Department.

PROJECT TITLE

The proposed Jindal Melmoth Iron Ore Project, located within the Mthonjaneni Local Municipality in the KZN Province

DISTRICT MUNICIPALITY

Mthonjaneni Local Municipality

1. SPECIALIST INFORMATION

Specialist name:	Marc Blanché		
Contact person:	Marc Blanché		
Postal address:	20 Sanhall Park, Kirsty Close, Ballito, Dolphin Coast		
Postal code:	4420	Cell:	082 821 33 88
Telephone:	032 946 0461	Fax:	N/A
E-mail:	marc.blanche@wkcgroup.com		
Professional affiliation(s) (if any)	South African Council for National Scientific Professions (SACNASP)		

Project Consultant / EAP:	SLR Consulting

DECLARATION OF INTEREST BY SPECIALIST

Contact person:	Kate Hamilton		
Postal address:	Suite 1 - Building D, Monte Circle, 178 Montecasino Boulevard, Johannesburg		
Postal code:	2191	Cell:	072 850 0801
Telephone:	+27 11 467 0945	Fax:	N/A
E-mail:	khamilton@slrconsulting.com		

2. DECLARATION BY THE SPECIALIST

I, Marc Blanché

General declaration:

- I act as the independent specialist in this application;
- do not have and will not have any vested interest (either business, financial, personal or other) in the undertaking of the proposed activity, other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2014;
- 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 am aware that a person is guilty of an offence in terms of Regulation 48 (1) of the EIA Regulations, 2014, if that person provides incorrect or misleading information. A person who is convicted of an offence in terms of sub-regulation 48(1) (a)-(e) is liable to the penalties as contemplated in section 49B(1) of the National Environmental Management Act, 1998 (Act 107 of 1998).

Signature of the specialist:

WKC Group

Name of company:

11/11/2022

Date:

Appendix C – Haul Route Emissions Methodology

Haul Roads

When vehicles travel on an unpaved road, the force of the wheels on the road surface causes pulverisation of road surface material. Particles are lifted and dropped from the rolling wheels, and the road surface is exposed to strong air currents in turbulent shear with the surface. The turbulent wake behind the vehicle continues to act on the road surface after the vehicle has passed. Dust emissions from unpaved roads have been found to vary directly with the fraction of silt in the road surface materials. The typical silt content of unpaved haul roads has been published by the US EPA as 10% [14] and, in the absence of site specific data, this value was used as an approximation.

The following empirical expressions may then be used to estimate the quantity in pounds (lb) of size-specific particulate emissions from an unpaved road, per vehicle mile travelled (VMT) [14]

$$E = k\left(\frac{s}{12}\right)^{a}\left(\frac{W}{3}\right)^{b}$$

Where:

a, b and k are empirical constants as shown in Table A-1 below, together with the values for silt content and mean vehicle weight.

Table A-1 – Haul Road Emission Factor Parameters for Unpaved Haul Roads

Constant	Symbol	Units	Value
Empirical constant	a	-	0.70
Empirical constant	b	-	0.45
Empirical constant	k	lb/VMT	4.90
Surface material silt content	S	%	5.80
Plant weight	W	T	275
Heavy vehicle weight			275
Car weight			1.15
Bus weight			9.00
Taxi weight			2.40

Appendix D – Construction Impact Assessment Methodology

The construction impact assessment detailed below has been extracted from the IAQM Guidance on the Assessment of Dust form Construction and Demolition [10].

A risk category is allocated to a site based on the following two factors:

- the scale and nature of the works, which determines the potential dust emission magnitude as "**Small**", "**Medium**" or "**Large**"; and,
- the sensitivity of the area to dust impacts, which is defined as "**Low**", "**Medium**" or "**High**" sensitivity.

These two factors are combined to determine the risk pf dust impacts with no mitigation applied. The risk category can be different for each of the four potential activities: demolition, earthworks, construction and trackout).

Define the Potential Dust Emission Magnitude

The dust emission magnitude is based on the scale of the anticipated works and should be classified as Small, Medium, or Large.

The following are examples of how the potential dust emission magnitude for different activities can be defined. Note that, in each case, not all the criteria need to be met, and that other criteria may be used if justified in the assessment:

Demolition

Definitions for demolition are:

- **Large**: Total building volume > 50,000 m^3, potentially dusty construction material (e.g. concrete), on-site crushing and screening, demolition activities > 20 m above ground level;
- **Medium**: Total building volume 20,000 m^3 – 50,000 m^3, potentially dusty construction material, demolition activities 10-20 m above ground level; and,
- **Small**: Total building volume <20,000 m^3, construction material with low potential for dust release (e.g. metal, cladding or timber), demolition activities < 10 m above ground, demolition during wetter months.

Earthworks

Earthworks will primarily involve excavating material, haulage, tipping and stockpiling. This may also involve levelling the site and landscaping. Example definitions for earthworks are:

- **Large**: Total site area < 10,000 m^2, potentially dusty soil type (e.g. clay, which will be prone to suspension when dry due to small particle size), > 10 heavy earth moving vehicles active at any one time, formation of bunds > 8 m in height, total material moved > 100,000 tonnes;

- **Medium**: Total site area 2,500 m^2 – 10,000 m^2, moderately dusty soil type (e.g. silt), 5-10 heavy earth moving vehicles active at any one time, formation of bunds 4 m - 8 m in height, total material moved 20,000 tonnes – 100,000 tonnes; and,

- **Small**: Total site area < 2,500 m^2, soil type with large grain size (e.g. sand), < 5 heavy earth moving vehicles active at any one time, formation of bunds < 4 m in height, total material moved < 20,000 tonnes, earthworks during wetter months.

Construction

The key issues when determining the potential dust emission magnitude during the construction phase include the size of the building(s)/infrastructure, method of construction, construction materials, and duration of build. Definitions for construction are:

- **Large**: Total building volume >100,000 m^3, on site concrete batching, sandblasting;

- **Medium**: Total building volume 25,000 m^3 – 100,000 m^3, potentially dusty construction material (e.g. concrete), on site concrete batching; and,

- **Small**: Total building volume < 25,000 m^3, construction material with low potential for dust release (e.g. metal cladding or timber).

Trackout

Factors which determine the dust emission magnitude are vehicle size, vehicle speed, vehicle numbers, geology and duration. As with all other potential sources, professional judgement must be applied when classifying trackout into one of the dust emission magnitude categories. Definitions for trackout are:

- **Large**: > 50 HDV (> 3.5 tonnes) outward movements[2] in any one day[3], potentially dusty surface material (e.g. high clay content), unpaved road length >100 m;

- **Medium**: 10-50 HDV (>3.5 tonnes) outward movements[2] in any one day, moderately dusty surface material (e.g. high clay content), unpaved road length 50 m – 100 m; and,

- **Small**: < 10 HDV (> 3.5 tonnes) outward movements[2] in any one day[3], surface material with low potential for dust release, unpaved road length < 50 m.

Define the Sensitivity of the Area

The sensitivity of the are takes into account a number of factors:

- The specific sensitivities of receptors in the area;

- The proximity and number of those receptors;

- In the case of PM_{10}, the local background concentration; and,

---

[2] A vehicle movement is a one way journey. i.e. from A to B, and excludes the return journey.
[3] HDV movements during a construction project vary over its lifetime, and the number of movements is the maximum not the average.

- Site-specific factors, such as whether there are natural shelters, such as trees, to reduce the risk of wind-blown dust.

The type of receptors at different distances from the site boundary or, if known, from the dust generating activities, should be included. Consideration also should be given to the number of 'human receptors'. Exact counting of the number of 'human receptors', is not required. Instead it is recommended that judgement is used to determine the approximate number of receptors (a residential unit is one receptor) within each distance band. For receptors which are not dwellings professional judgement should be used to determine the number of human receptors for use in the tables, for example a school is likely to be treated as being in the > 100 receptor category.

The likely routes the construction traffic will use should also be included to enable the presence of trackout receptors to be included in the assessment. As general guidance, without site-specific mitigation, trackout may occur along the public highway up to 500 m from large sites, 200 m from medium sites and 50 m from small sites, as measured from the site exit.

A number of attempts have been made to categorise receptors into high, medium and low sensitivity categories; however, there is no unified sensitivity classification scheme that covers the quite different potential effects on property, human health and ecological receptors.

Table A – 1, Table A – 2 and Table A – 3 show how the sensitivity of the area may be determined for dust soiling, human health and ecosystem impacts respectively. These tables take account of a number of factors which may influence the sensitivity of the area. When using these tables, it should be noted that distances are to the dust source and so a different area may be affected by trackout than by on-site works. The highest level of sensitivity from each table should be recorded.

Table A – 1 - Sensitivity of the Area to Dust Soiling Effects on People and Property [a,b]

Receptor Sensitivity	Number of Receptors	Distance from Source (m)[c]			
		< 20	< 50	< 100	< 350
High	> 100	High	High	Medium	Low
	10 – 100	High	Medium	Low	Low
	1 – 10	Medium	Low	Low	Low
Medium	> 1	Medium	Low	Low	Low
Low	> 1	Low	Low	Low	Low

Notes:

a: The sensitivity of the area should be derived for each of the four activities: demolition, construction, earthworks and trackout.

b: Estimate the total number of receptors within the stated distance. Only the highest level of area sensitivity from the table needs to be considered.

c: For trackout, the distances should be measured from the side of the roads used by construction traffic. Without sitespecific mitigation, trackout may occur from roads up to 500 m from large sites, 200 m from medium sites and 50 m from small sites, as measured from the site exit. The impact declines with distance from the site, and it is only necessary to consider trackout impacts up to 50 m from the edge of the road.

Table A – 2 - Sensitivity of the Area to Human Health Impacts [a,b]

Receptor Sensitivity	Annual Mean PM_{10} Concentration [c]	Number of Receptors [d]	Distance from Source (m) [e]				
			< 20	< 50	< 100	< 200	< 350
High	> 32 µg/m³	> 100	High	High	High	Medium	Low
		10 – 100	High	High	Medium	Low	Low
		1 – 10	High	Medium	Low	Low	Low
	28 -32 µg/m³	> 100	High	High	Medium	Low	Low
		10 – 100	High	Medium	Low	Low	Low
		1 – 10	High	Medium	Low	Low	Low
	24 – 28 µg/m³	> 100	High	Medium	Low	Low	Low
		10 – 100	High	Medium	Low	Low	Low
		1 – 10	Medium	Low	Low	Low	Low
	< 24 µg/m³	> 100	Medium	Low	Low	Low	Low
		10 – 100	Low	Low	Low	Low	Low
		1 – 10	Low	Low	Low	Low	Low
Medium	> 32 µg/m³	< 10	High	Medium	Low	Low	Low
		1 – 10	Medium	Low	Low	Low	Low
	28 -32 µg/m³	< 10	Medium	Low	Low	Low	Low
		1 – 10	Low	Low	Low	Low	Low
	24 – 28 µg/m³	< 10	Low	Low	Low	Low	Low
		1 – 10	Low	Low	Low	Low	Low
	< 24 µg/m³	< 10	Low	Low	Low	Low	Low
		1 – 10	Low	Low	Low	Low	Low
Low	-	≥ 1	Low	Low	Low	Low	Low

Notes:

a: The sensitivity of the area should be derived for each of the four activities: demolition, construction, earthworks and trackout.

b: Estimate the total within the stated distance (e.g. the total within 350 m and not the number between 200 and 350 m), noting that only the highest level of area sensitivity from the table needs to be considered.

c: Most straightforwardly taken from the national background maps, but should also take account of local sources. The values are based on 32 µg/m3 being the annual mean concentration at which an exceedence of the 24-hour objective is likely in England, Walesand Northern Ireland.

d: In the case of high sensitivity receptors with high occupancy (such as schools or hospitals) approximate the number of people likely to be present. In the case of residential dwellings, just include the number of properties.

e: For trackout, the distances should be measured from the side of the roads used by construction traffic. Without sitespecific mitigation, trackout may occur from roads up to 500 m from large sites, 200 m from medium sites and 50 m from small sites, as measured from the site exit. The impact declines with distance from the site, and it is only necessary to consider trackout impacts up to 50 m from the edge of the road.

Table A – 3 - Sensitivity of the Area to Ecological Impacts [a,b]

Receptor Sensitivity	Distance from Source (m)[c]	
	< 20	< 50
High	High	Medium
Medium	Medium	Low
Low	Low	Low

Notes:

a: The sensitivity of the area should be derived for each of the four activities: demolition, construction, earthworks and trackout.

b: Only the highest level of area sensitivity from the table needs to be considered.

c: For trackout, the distances should be measured from the side of the roads used by construction traffic. Without sitespecific mitigation, trackout may occur from roads up to 500 m from large sites, 200 m from medium sites and 50 m from small sites, as measured from the site exit. The impact declines with distance from the site, and it is only necessary to consider trackout impacts up to 50 m from the edge of the road.

The dust emission magnitude determined should be combined with the sensitivity of the area to determine the risk of impacts with no mitigation applied. The matrices in Table A – 4, Table A – 5, Table A – 6 and Table A – 7 provide a method of assigning the level of risk for each activity. This should be used to determining the level of mitigation that must be applied.

Table A – 4 - Risk of Dust Impacts - Demolition

Sensitivity of Area	Dust Emission Magnitude		
	Large	Medium	Small
High	High Risk	Medium Risk	Medium Risk
Medium	High Risk	Medium Risk	Low Risk
Low	Medium Risk	Low Risk	Negligible

Table A – 5 - Risk of Dust Impacts - Earthworks

Sensitivity of Area	Dust Emission Magnitude		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Medium Risk	Low Risk
Low	Low Risk	Low Risk	Negligible

Table A – 6 - Risk of Dust Impacts - Construction

Sensitivity of Area	Dust Emission Magnitude		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Medium Risk	Low Risk
Low	Low Risk	Low Risk	Negligible

Table A – 7 - Risk of Dust Impacts - Trackout

Sensitivity of Area	Dust Emission Magnitude		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Low Risk	Negligible
Low	Low Risk	Low Risk	Negligible

Appendix E – Dust and PM Apportionment Controls

In order to accurately define and propose site specific management objectives, the main emission sources were identified, and ranked based on the Project activities. Once the main emission sources were identified, target control efficiencies for each source were defined for potential implementation.

Source Ranking

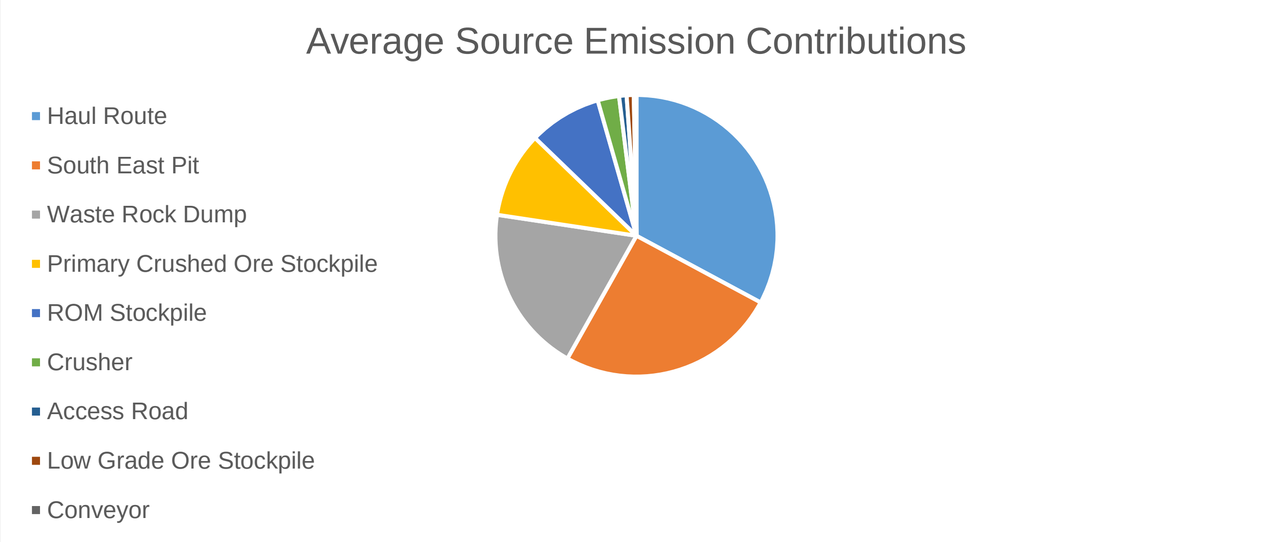
The ranking of sources serves to confirm the current understanding of the significance of specific sources, and to evaluate the emission reduction potentials required for each.

Ranking of Sources by Emissions

On average, sources of emission are ranked as follows from most to least significant:

1. Wheel entrained dust from unpaved haul routes;
2. Mining operations within the South East Pit;
3. Operations within the WRD;
4. Primary Crushed Ore and ROM Stockpiles;
5. Crusher;
6. Access Road;
7. Low Grade Ore Stockpile; and,
8. The Conveyor between the Crusher and the Process Plant.

Figure D - 1 – Average Source Emission Contributions



As presented in Figure D - 1, measures aimed at reducing emissions from unpaved roads, exposed areas and material handling within the southeast pit and WRD should be considered as a priority. The following sections detail source specific management and mitigations measures as recommended specifically for unpaved roads and windblown dust which will be prevalent in the above-mentioned working areas.

Source Specific Management and Mitigation Measures

Dust Control for Unpaved Roads

Multiple methods are available for haul route dust control. The following are considered the most suitable methods which may be implemented to reduce emissions from unpaved haul roods:

- Adequate road design;
- Measures aimed at reducing the extent of the unpaved roads, e.g. paving or films;
- Traffic control measures directed at reducing the entrainment of material by restricting traffic volumes and reducing vehicle speeds; and,
- Measures such as water suppression or chemical stabilisation aimed at binding the surface material or enhancing moisture retention [15].

The design of unpaved mine haul roads encompasses structural, functional and maintenance design aspects. The structural design ensures that the haul road can carry the imposed loads without the need for excessive maintenance, whereas functional design is concerned with the choice, application and maintenance of wearing-course (surfacing) materials. Although optimal selection of wearing-course material parameters can reduce the potential for dust generation, it cannot totally eliminate it, and so considerable time and expenditure are applied to the reduction of vehicle generated haul-road dust [16].

A well planned and designed haul road will allow for easier management and maintenance, increased productivity (becoming more cost effective) and minimise emissions of particulate matter. The design factors that are relevant to the minimisation of particulate matter emissions are [17]:

- Design of haul road cross section:

- The preparation of a suitable road sub-base. Studies recommend a California Bearing Ratio (CBR) of over 80% for the wearing course material to minimise rutting, sinking and overall deterioration of the road;
- The placement of materials within the cross section of the haul roads so the stiffest material is placed as close to the upper surface as possible; and,
- The amount of compaction of material within the cross-sectional design.

- Road construction materials:
  - The composition of the material used for the haul road has a significant impact on the tendency for emissions of particulate matter to occur. The surface material selected for haul road construction is most frequently gravel or crushed stone. This is mainly due to cost effectiveness of the material and availability. However, the actual cost effectiveness of this material may be poor over the longer term if a large amount of maintenance is required;
  - The type of aggregate used dictates the most suitable approaches to control particulate matter emissions. For example, for gravel road surfaces with minimal fines, chemical suppressants cannot compact the surface or form a new surface and therefore do not provide a substantial additional benefit from watering alone; and,
  - The durability of the material used for the road surface is critical. A number of studies have shown that haul road deterioration was caused by watering, rain and run off. The deterioration of a haul road may lead to increased nuisance issues. However, a well-designed haul road will resist deterioration and will enable management and maintenance actions to be implemented more readily, improving energy efficiency, driver comfort and emissions of particulate matter as a consequence.
- Road Surface:
  - Particulate matter emissions are proportional to the silt content of the material used for the road (i.e. lower silt content will result in a lower emission rate of particulate matter); and,
  - The silt content of the road surface will determine how successful suppressants may be. For example at silt contents greater than 20-25% suppressants are unlikely to be effective.
- Haulage road planning and alignment:
  - Particulate matter emissions are proportional to vehicle kilometres travelled (VKT) (i.e. lower VKT will result in a lower emission rate of particulate matter);
  - Limiting the amount of traffic and speed of vehicles on unpaved haul roads has been shown to be an effective mitigation technique; and,
  - Conveyors can be used in place of haul roads, particularly on high traffic routes that are relatively static during the mine life.

The main dust generating factors on unpaved roads include [18]:

- Vehicle speed;
- Number of wheels per vehicle;
- Traffic volume;

- Particle size distribution of the aggregate;
- Compaction of the surface material;
- Surface moisture; and,
- Climate.

The Desert Research Institute at the University of Nevada conducted research concluding that an increase in vehicle speed of 16 kilometre per hour (km/hr) is expected to result in an increase in PM_{10} emissions of between 1.5 to 3 times. Similarly, a study conducted at the University of California [19] suggested that a reduction of travel speeds on unpaved roads from 40 km/hr to 24 km/hr reduced PM_{10} emissions by 42±35%.

A study undertaken at 10 mines in Southern Africa [20] found that even though water sprays on unpaved roads are the most common means of dust suppression on haul roads, it is not necessarily the most efficient method or means. A number of chemical products, including hygroscopic salts, lignosulponates, petroleum resins, polymer emulsions and tar and bitumen products were assessed to benchmark their performance and identify appropriate management strategies. Cost elements taken into consideration included amongst others equipment, operation and maintenance costs, material costs and activity related costs. The main findings were that water-based spraying is the cheapest dust suppression option over the short term. Over the longer term however, the polymer-emulsion option is marginally cheaper with added benefits such as improved road surfaces during wet weather, reduced erosion and dry skid resistance [20].

In many instances, chemical suppressants have an advantage over plain water as chemical suppressants agglomerate fine PM on the road surface hence, increase the density of the surface material. In addition to dust controls, chemical suppressants also improve the compaction and stability of the road. The effectiveness of any chemical suppressant include numerous factors such as the application rate, method of application, moisture content of the surface material during application, chemical suppressant concentrations, mineralogy of aggregate and environmental conditions. Therefore, different climates and site conditions require different chemical suppressants each of which having inherent advantages and limitations of their own. In general, chemical suppressants are expected to achieve a PM_{10} control efficiency of 80% when applied regularly on the road surfaces [18].

Options for Reducing Windblown Dust Emissions

The main techniques adopted to reduce windblown dust potential include source extent reduction, source improvement and surface treatment methods:

- Source extent reduction:
- Disturbed area reduction;
- Disturbance frequency reduction; and,
- Dust spillage prevention and / or removal.
- Source Improvement:
- Disturbed area wind exposure reduction, e.g. wind fences and enclosure of source areas.
- Surface Treatment:
- Wet suppression;
- Chemical stabilisation;

- Covering of surface with less erodible aggregate material; and,
- Vegetation of open areas.

The suitability of the dust control techniques indicated will depend on the specific source to be addressed, and will vary between dust spillage, material storage and open areas. The NPI recommends the following methods for reducing windblown dust [11]:

- Primary rehabilitation - 30%;
- Vegetation established but not demonstrated to be self-sustaining. Weed control and grazing control - 40%;
- Secondary rehabilitation - 60%;
- Re-vegetation - 90%; and,
- Fully rehabilitated (release) vegetation - 100%.

In addition to the above, it is recommended that in consultation with the Project ecologist, a buffer of fast growing indigenous vegetation is planted around the entire perimeter of the mine areas. This will act as a natural wind barrier, provide additional habitat, as well as provide a visual buffer between the community and the mine.

Materials Handling Dust Control Options

Source extent reduction, source improvement relating to work practices and transfer equipment and surface treatment are considered control techniques applicable to materials handling. These control techniques may be summarised as follows [21]:

- Source extent reduction:
- Mass transfer reduction.
- Source improvement:
- Drop height reduction;
- Wind sheltering; and,
- Moisture retention.
- Surface treatment:
- Wet suppression, and,
- Air atomising suppression.

The efficacy of the above-mentioned techniques is dependent on climatic parameters, material properties and quantities of materials being transferred.

Wet suppression systems, utilizing liquid sprays or foam to suppress the formation of airborne dust, prevent dust emissions through the agglomeration of fine dust particles. Liquid spray suppression systems use either water or combination of water and chemical suppressants as the wetting agent. Addition of surfactants reduce the surface tension of the water allowing particles to more easily penetrate the water particle as such reducing the amount of water required to achieve the required efficiency.