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ENVIRONMENTAL

Xivono Weltevreden Mining Project near Belfast, Mpumalanga

Air Quality Impact Assessment

Project Number:

MBU5710

Prepared for:

Xivono Mining (Pty) Ltd

November 2019

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Report Type:	**Air Quality Impact Assessment**
Project Name:	**Xivono Weltevreden Mining Project near Belfast, Mpumalanga**
Project Code:	**MBU5710**

Name	Responsibility	Signature	Date
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Barbara Wessels	Reviewer		November 2019

DECLARATION OF INDEPENDENCE

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I, Matthew Ojelede as duly authorised representative of Digby Wells and Associates (South Africa) (Pty) Ltd., hereby confirm my independence (as well as that of Digby Wells and Associates (South Africa) (Pty) Ltd.) and declare that neither I nor Digby Wells and Associates (South Africa) (Pty) Ltd. have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of Xivono Mining (Pty) Ltd, other than fair remuneration for work performed, specifically in connection with the Air Quality Impact Assessment for the proposed Xivono Mine (Pty) Weltevreden Mine, Mpumalanga Province.

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EXECUTIVE SUMMARY

Xivono Mining (Pty) Ltd (hereinafter Xivono) holds an approved Prospecting Right[1] in the Mpumalanga Province. Xivono intends to convert the Prospecting Right into a Mining Right for the proposed Weltevreden Mining Project (the Project). The Applicant, Xivono, appointed Digby Wells Environmental as the independent Environmental Assessment Practitioner (EAP) to undertake the Environmental Authorisation (EA) process.

This report constitutes the specialist Air Quality Impact Assessment (AQIA), which was compiled to comply with the requirements as stipulated in the South African legal framework. The AQIA commenced with baseline data collected onsite for a period of three months. Ambient pollutants levels for particulate matter with aerodynamic diameter less than 10 micron (PM_{10}), particulate matter with aerodynamic diameter less than 2.5 micron ($PM_{2.5}$), nitrogen dioxide (NO_2), ozone (O_3) and carbon monoxide (CO) were measured. Thereafter, an emission inventory was conducted, and emissions rates generated served as input parameters used in the dispersion model simulations to predict pollutants Ground Level Concentrations (GLC). The GLC for Total Suspended Particulates (TSP) with aerodynamic diameter less than 30 micron, PM_{10} and $PM_{2.5}$ were generated using the American Meteorological Society and United States Environmental Protection Agency (USEPA) Regulatory Model (AERMOD). AERMOD was configured for an analysis of a 20 km^2 study domain. Isopleths were generated for different averaging periods recommended by the regulatory authorities and compared with the South African standards to ascertain compliance.

A summary of the findings from the AQIA study is given below:

- The predicted exceedances of the 24-hour standard of 40 µg/m³ will occur within the Project boundary, extending out in the eastern and western directions. The GLC at Siyathuthuka and Belfast, the nearest receptors, will be lower than the standard. The annual GLC of $PM_{2.5}$ predicted will not exceed standard outside the Project boundary. However, an area onsite will experience exceedance of the annual limit (25 µg/m³). It is believed that with mitigation measures in place, emissions will be contained, and ambient concentrations will be reduced below regulatory limit values.
- Areas where exceedance of the South African 24-hour standard (75 µg/m³) will occurred extends outside the Project boundary to the east, south and west respectively. This is without mitigation measures in place. The GLC predicted for Siyathuthuka and Belfast were below the standard. The predicted annual GLC showed that areas where exceedances will occur are within the Project boundary. This will fall under the Occupational Hygiene regulation and will not be discussed in this report. The annual GLC predicted at Siyathuthuka and Belfast were all below the South African standard.

[1] Reference number MP 1320 PR. The Prospecting Licence will lapse on 22 August 2021 as authorised by the Department of Mineral Resources (DMR).

- The predicted dust deposition rates confirm that the non-residential limit of 1,200 mg/m^2/day will be exceeded onsite and outside the Project boundary without mitigation measures in place. However, with mitigation measures factored into the day to day operation at the mine, exceedances will be limited to the Project boundary. The predicted exposure levels at the Siyathuthuka and Belfast were within the residential limit of 600 mg/m^2/day.

Considering the low levels of PM_{10} and $PM_{2.5}$ measured in the vicinity of the proposed Project, it is not anticipated that cumulative levels as a result of the operational phase of the Project will exceed regulatory limit values.

Although the findings from this study indicates major (negative) impacts during the operational phase, this represented the worst-case scenario (without mitigation measures in place). With mitigation measures applied, as shown with the dust deposition rates, exceedances of the limit values were confined to the Project boundary.

Based on the isopleths of GLC predicted, management must ensure intervention measures to mitigate and further reduce emissions at source are part of the day-to-day practices on commencement of the mining operations.

Despite the aforementioned, the air quality specialist does not object to the Project from an air quality perspective as envisaged impacts will be insignificant after the recommended mitigation measures are applied.

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ACRONYMS, ABBREVIATIONS AND DEFINITION

AERMOD	American Meteorological Society/United States Environmental Protection Agency Regulatory Model
AQIA	Air Quality Impact Assessment
CO	Carbon Monoxide
DEA	Department of Environmental Affairs
EAP	Environmental Assessment Practitioner
EMP	Environmental Management Plan
GLC	Ground Level Concentrations
LOM	Life of Mine
MM5	Mesoscale model - Fifth generation
MPRDA	Mineral and Petroleum Resource Development Act
NEMA	National Environmental Management Act
NO_2	Nitrogen Dioxide
O_3	Ozone
PM_{10}	Particulate Matter with Aerodynamic Diameter less than 10 Micron
$PM_{2.5}$	Particulate Matter with Aerodynamic Diameter less than 2.5 Micron
ROM	Run of Mine
TSP	Total Suspended Particulates
tpa	Tonnes per annum
USEPA	United States Environmental Protection Agency
WHO	World Health Organisation

1 Introduction

Xivono Mining (Pty) Ltd (hereinafter Xivono) holds an approved Prospecting Right[2] near Belfast in the Mpumalanga Province. Xivono intends to convert the Prospecting Right into a Mining Right for the proposed Weltevreden Mining Project (the Project). The Applicant, Xivono appointed Digby Wells Environmental (hereinafter Digby Wells) as the independent Environmental Assessment Practitioner (EAP) to undertake the Environmental Authorisation (EA) process.

This report constitutes the specialist Air Quality Impact Assessment (AQIA), which was compiled to comply with the requirements as stipulated in the South African legal framework:

- Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) (MPRDA), Part IV, Section 48(1), 49 and 50;
- National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA), Sections 24(1), (3) and (7); and
- National Environmental Management: Air Quality Act, 2004 (Act 39 of 2004).

This is not a health study, however, the predicted Ground Level Concentration (GLC) of pollutants from the Project are used to determine future exposure levels and potential health implications from exposure.

According to the World Health Organization (WHO, 2000), guidelines provide a basis for protecting public health from adverse effects of air pollution and for eliminating or reducing to minimum ambient levels of pollutants that are known or likely to be hazardous to human health and wellbeing. Once the guidelines are adopted as standards, they become legally enforceable. These standards prescribe the allowable ambient concentrations of pollutants which are not to be exceeded during a specified time period in a defined area. If the air quality guidelines/standards are exceeded, the ambient air quality is poor and the potential for health effects is greatest.

2 Project Background and Description

The Project is located approximately 8 km south of Belfast in the Emakhazeni Local Municipality (ELM) and the Nkangala District Municipality (NDM) of the Mpumalanga Province. At present, Xivono intend to establish infrastructure on the portion of the Prospecting Right area to the west of the R33 road.

The proposed infrastructure includes two Open-Cast (OC) pits, OC1 and OC2. These pits will occupy 162 ha and 200 ha respectively. OC1 has in excess of 5 million tonnes of in-situ minable tonnes of coal at a depth of approximately 20 m below surface. OC1 will target the 2

[2] Reference number MP 1320 PR. The Prospecting Licence will lapse on 22 August 2021 as authorised by the Department of Mineral Resources (DMR).

Seam which is an average of 2.7 m thick. OC2 will target the Upper 4 Seam, Lower 4 Seam and 2 Seam which reaches a maximum depth of about 30 m. OC2 will yield approximately 10 million tonnes of coal. The coal product will be for supply directly to Eskom. Coal from seams 2A, Seam 2D and Seam 2E are used as a blend to improve the inferior qualities coal from Seam 2B, 2C and Seam 4L where the blending ratio is 3:1.

Other surface infrastructure proposed for the site includes pollution control dams, a crushing and screening plant (no washing to take place on site), Run of Mine (ROM) pad, overburden dump, stockpiles, pipelines, weighbridge, diesel storage and lined trenches.

This application pertains only to open-pit mining for two pits and the associated crushing and screening activities. The total proposed quantity of coal to be extracted is approximately 15 million tonnes over a 15-year Life of Mine (LOM). Currently, Pit OC1 will be mined first in a west-east direction and Pit OC2 will be mined thereafter in a south-north direction, with an assumed production rate of 150 000 tonnes of coal mined per month for the total pit area. Coal crushing and screening will take place on site and trucked directly to Eskom.

3 Terms of Reference

The Terms of Reference (ToR) for Digby Wells as the EAP is to complete the EA process, and the AQIA forms part of a suite of specialist studies required to fulfil this process. The AQIA was conducted to comply Part III, Section 48(1), 49 and 50 of the MPRDA (as amended, Government Notice R349 in Government Gazette 34225 dated 18 April 2011) and Sections 24(1), (3) and (7) of NEMA.

3.1 Scope of Work

Based on the requirements of the Project, the air quality Scope of Work (SoW) in compliance with the South African requirements encompasses the following:

- Establishment of the site meteorology and collection of ambient air quality data in the Project area;
- Assessment of the potential air quality impacts from the proposed Project and comparison of the predicted GLC against the regulatory standards for compliance; and
- Recommendation of management measures, including mitigation and monitoring requirements.

4 Details of the Specialist

Matthew Ojelede is an air quality specialist at Digby Wells & Associates (Pty) Ltd, and the Manager at the Department of Atmospheric Sciences and Noise. He holds degrees in BSc Geology (Hons) from the University of Benin, Edo State, Nigeria; an MSc in Environmental Science from the University of the Witwatersrand and a PhD in Environmental Management from the University of Johannesburg. He is a member of the South African Council for Natural Scientific Professions (SACNASP), and the National Association for Clean Air (NACA). He

has authored and co-authored research articles and conference papers in peer reviewed journals both locally and internationally.

He has attended specialized courses in atmospheric dispersion modelling (AERMOD and CALPUFF).

5 Assumptions, Limitations and Exclusions

Assumptions, limitations and exclusions pertaining to the Project are discussed in Table 5-1.

Table 5-1:Assumptions, Limitations and Exclusions

Assumption, Limitation or Exclusion	Consequence
Assumed that electricity will be solely from the national grid, while an emergency generator will be used intermittently	Less particulate and gaseous emissions to the ambient environments
Gaseous emissions from blasting were not assessed because this was considered negligible	No real consequences as this is considered negligible
Uncertainty associated with dispersion models	Mining activities were selected to demonstrate the worst-case scenario, the predicted GLC may result in over-estimating the magnitude

6 Relevant Legislation, Standards and Guidelines

6.1 South African Legislation and Regulation

The NEMA as amended provides a legislative framework for environmental management in South Africa. Principles from NEMA are relevant to air pollution, Section 24(4) b(i) … "*the investigation and* assessment of the potential impacts of activities that require authorisation or permission.", and Section 24(7). As mentioned in the ToR, the MPRDA, which requires an environmental impact assessment …" *identify and describe the anticipated environmental, social and cultural impacts, including the cumulative effects"* to be conducted.

The prevailing legislation in the Republic of South Africa with regards to the Air Quality is the National Environment Management: Air Quality Act (Act No. 39 of 2004) (NEM: AQA). NEM: AQA forms one of the many pieces of legislations that falls under the ambit of the NEMA.

NEM: AQA puts in place various measures for the prevention of pollution and national norms and standards for the regulation of air quality in South Africa. It also authorizes the Minister of Environmental Affairs to enforce its provisions through the issuance of policy documents and regulations. As in section 24G of NEMA, section 22A of NEM: AQA has a provision for administrative fine for contravention. In line with NEMAQA, the Department of Environmental Affairs (DEA) published National Dust Control Regulations (NDCR), the acceptable dust fallout limits for residential and non-residential areas (Government Gazette 36975, Government Notice R827, 01 November 2013). The dust fallout standard is given in the Table 6-1 below.

Table 6-1: Dust Fall Standards (NEMAQA - NDCR, 2013)

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

The DEA has established National Ambient Air Quality Standards for PM_{10} and gases in Table 6-2 since December 2009 and $PM_{2.5}$, since June 2012 (GN 486: 2012) as in Table 6-3.

Table 6-2: National Ambient Air Quality Standards for Particulate Matter (PM_{10}) (2009)

Averaging Period	Limit Value (µg/m3)	Limit Value (ppb)	Frequency of Exceedance	Compliance Date
National Ambient Air Quality Standard for Sulphur Dioxide (SO_2)				
10 Minutes	500	191	526	Immediate
1 hour	350	134	88	Immediate
24 hours	125	48	4	Immediate
1 year	50	19	0	Immediate
The reference method for the analysis of SO_2 shall be ISO 6767.				
National Ambient Air Quality Standard for Nitrogen Dioxide (NO_2)				
1 hour	200	106	88	Immediate
1 year	40	21	0	Immediate
The reference method for the analysis of NO_2 shall be ISO 7996.				
National Ambient Air Quality Standard for Particulate Matter (PM_{10})				
24 hours	75		4	1 January 2015
1 year	40		0	1 January 2015
The reference method for the determination of the PM10 fraction of suspended particulate matter shall be EN 12341.				
National Ambient Air Quality Standard for Ozone (O_3)				
8 hours (running)	120 (61ppb)		11	Immediate
The reference method for the analysis of ozone shall be the UV photometric method as described in SANS 13964.				
National Ambient Air Quality Standard for Carbon Monoxide (CO) mg/m3				
1 hour	30	26 (ppm)	88	Immediate
8 hours (calculated on 1 hourly averages)	10	8.7 (ppm)	11	Immediate
The reference method for analysis of CO shall be ISO 4224.				

Table 6-3: National Ambient Air Quality Standards for Particulate Matter ($PM_{2.5}$) (2012)

National Ambient Air Quality Standards for Particulate Matter (PM2.5)			
Averaging Period	**Limit Value (µg/m3)**	**Frequency of Exceedance**	**Compliance Date**
24 hours	40	0	1 January 2016 – 31 December 2029
24 hours	25	0	01 January 2030
1 year	20	0	1 January 2016 – 31 December 2029
1 year	15	0	01 January 2030
The reference method for the determination of PM2.5 fraction of suspended particulate matter shall be EN 14907.			

In addition to the aforementioned, another piece of regulation that guided this assessment is the NEM:AQA Regulation Regarding Air Dispersion Modelling in Government Gazette 37804, Government Notice R 533, July 2014. A Level 3 assessment in the regulation was used, which required detailed meteorological geophysical and source input data prior to dispersion modelling.

7 Methodology

7.1 Assessment of Baseline Environment, Climate and Air Quality

A desktop assessment of Google Earth Imagery® of the area to identify the sensitive receptors and other possible sources of pollutants was conducted. In addition, the climate and air quality of the Project area was assessed, using modelled and real-time ambient air quality measurements collected on site.

Modelled Lakes meteorological data encompasses parameters; such as, rainfall, temperature, relative humidity and wind speed and wind direction.

In addition, air quality data measured with a real-time monitor collected ambient measurements for pollutants, such as: PM_{10}, $PM_{2.5}$, SO_2, O_3 and NO_2 for a period of three months (August, September and October 2019). These measurements were subsequently exported to Excel® for statistical analysis and interpretation, before making comparison against the regulatory NAM:AQA standards.

7.2 Assessment of Operational Impacts

The following section provides the methodology adopted to complete the AQIA. The construction and closure phases will be short-term with negligible impacts on the environment,

hence, are not considered in this AQIA. The approach adopted to determine the future impacts from the operational phase of the Project is detailed below.

The following section provides the methodology used to assess the operational impacts the Project is expected to have on the air quality of the area.

7.2.1 Impact Assessment Approach

The methodology adopted in assessing the impacts from the proposed mining operation and related activities is provided in Figure 7-1.

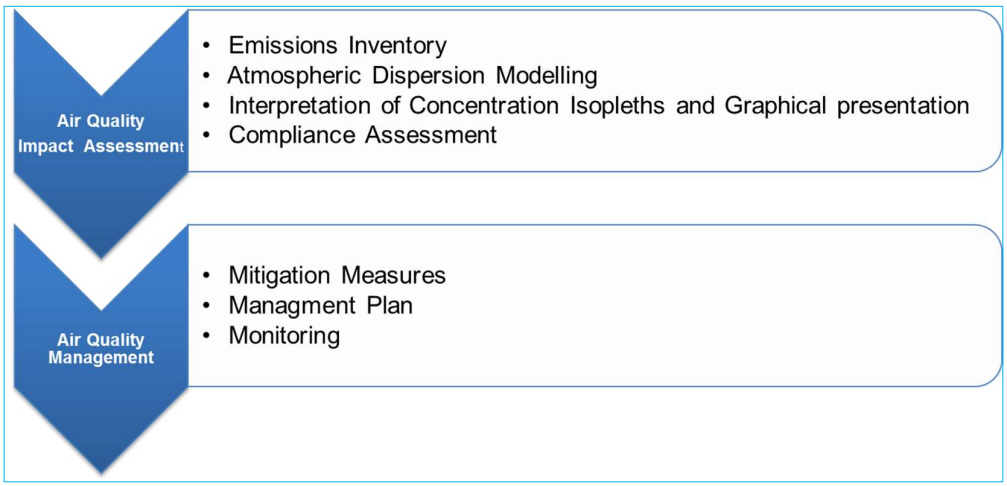

Figure 7-1: Air Quality Impact Assessment Methodology

In the impact assessment, tasks to be completed include the development of the emissions inventory, followed by model simulations to predict GLC of criteria pollutants. The findings of the impact assessment were used to assess compliance with regulations and informs the mitigation measures recommended and management plan, as well as monitoring requirements for the Project.

7.2.1.1 Emissions Inventory

The development of an emissions inventory forms the basis for any AQIA. Emission rates are typically obtained using actual sampling equipment at the point of emission or are estimated from mass and energy balances or emission factors which have been established at similar operations. Emission factors published by the USEPA in its AP-42 document “Compilation of Air Pollution Emission Factors” (USEPA, 1995; 1998; 2016) and Australian National Pollutant Inventory “Emission Estimation Technique (EET, 2012)” manuals were employed.

Quoting directly from the USEPA AP-42 (2016), …”*air pollutant emission factors are representative values that attempt to relate the quantity of a pollutant released to the ambient air with an activity associated with the release of that pollutant. These factors are usually expressed as the weight of pollutant divided by a unit weight, volume, distance, or duration of the activity emitting the pollutant. Such factors facilitate estimation of emissions from various*

sources of air pollution. In most cases, these factors are simply averages of all available data of acceptable quality, and are generally assumed to be representative of long-term averages".

The approach recommended in the USEPA (2006) was applied. The equations and parameters used in the calculations of the emissions expected from various sources within the proposed operation are discussed in detail in Table 7-1.

Table 7-1: Emission Factor Equations

Activity	Emission Equation	Source	Information assumed/provided
Materials handling (including conveying)	$EF_{TSP(kg/t)} = k_{TSP} \times 0.0016 \times \frac{\left(\frac{U_{(m/s)}}{2.2}\right)^{1.3}}{\left(\frac{M_{(\%)}}{2}\right)^{1.4}}$ Where, E = Emission factor (kg dust / t transferred) U = Mean wind speed (m/s) M = Material moisture content (%) The $PM_{2.5}$, PM_{10} and TSP fraction of the emission factor is 5.3%,0 35% and 0 74% respectively. An average wind speed of 3.8 m/s was used based on the Lakes Environmental data for the period 2016 – 2018.	US-EPA AP42 Section 13.2.4	<u>The moisture content of materials are as follows:</u> ROM:3.7% (Scorpion Mineral Processing, 2014); Discard Dump:3.0% (Assumed) Topsoil Stockpile: 6.9% (Assumed) The throughput of ore was 1,800,000 tpa Hours of operation were given as 24 hrs per day, 7 days per week.
Vehicle entrainment on unpaved surfaces	$EF_{(\frac{KG}{VKT})} = \frac{0.4536}{1.6093} * k * (\frac{s(\%)}{12}) a * (\frac{w(t)}{3}) b$ Where, E = particulate emission factor in grams per vehicle km travelled (g/VKT) k = basic emission factor for particle size range and units of interest s = road surface silt content (%) W = average weight (tonnes) of the vehicles travelling the road = 40 t side truck The particle size multiplier (k) is given as 0.15 for $PM_{2.5}$ and 1.5 for PM_{10}, and as 4.9 for TSP The empirical constant (a) is given as 0.9 for $PM_{2.5}$ and PM_{10}, and 4.9 for TSP	US-EPA AP42 Section 13.2.2	In the absence of site-specific silt data, use was made of the default silt content: Mine Road: 6.9% Operational transport activities onsite include the transport of imported ore to the stockpile at the plant. Hours of operation were assumed as 24 hrs per day, 7 days per week. The layout of the haul roads was assumed to be 10 m.

Activity	Emission Equation	Source	Information assumed/provided
	The empirical constant (b) is given as 0.45 for $PM_{2.5}$, PM_{10} and TSP		The throughput of material was provided as 1,800,000 tpa, with a ratio of 1.0 mt to 2.0 mt of discard.
Crushing and screening	Primary: $E_{TSP} = 0.03\ \text{kg/t material processed}$ Secondary: $E_{TSP} = 0.01\ \text{kg/t material processed}$ Where, E = Default emission factor for low moisture content ore	NPI, 2012: Mining	The throughput of material was provided as 1,800,000 tpa ore. Hours of operation were given as 24 hrs per day, 7 days per week. Primary crushing and secondary crushing occurring at the plant.
Wind Erosion	$E_{TSP} = 1.9 \times \left(\frac{s}{1.5}\right) \times \left(\frac{365-p}{235}\right) \times \left(\frac{f}{15}\right)$	USEPA, 1998	The silt contents of materials are as follows: Coal:4.0% Soft and Hard Stockpiles: 3.0% (Assumed) Topsoil: 6.9% (Assumed)
Tipping	$E_{TSP} = 0.74 \times 0.0016 \times \left(\frac{U}{2.2}\right)^{1.3} \times \left(\frac{M}{2}\right)^{-1.4}$ $E_{PM10} = 0.35 \times 0.0016 \times \left(\frac{U}{2.2}\right)^{1.3} \times \left(\frac{M}{2}\right)^{-1.4}$	US-EPA AP42 Section 13.2.4	The silt contents of materials are as follows: Coal:4.0% Soft and Hard Stockpiles: 3.0% U = mean wind speed in m/s M = moisture content in %

7.2.1.2 Air Quality Dispersion Modelling

Dispersion models compute ambient concentrations as a function of source configurations, emission rates and meteorological characteristics, thus providing a useful tool to ascertain the spatial and temporal patterns in GLCs of pollutants arising from the emissions of various sources. All emission scenarios would be simulated using the USEPA's Preferred / Recommended Models: AERMOD modelling system.

The AERMOD modelling system incorporates air dispersion based on a planetary boundary layer turbulence structure and scaling concepts, including both surface and elevated sources, and of simple or complex terrain.

The mesoscale model, known as MM5 (Fifth-Generation Penn State/NCAR Mesoscale Model) is a limited-area, non-hydrostatic, terrain-following sigma-coordinate model designed to simulate or predict meso-scale atmospheric circulation. MM5 modelled meteorological data sets for full three calendar years was obtained from Lakes Environmental in Canada. This

dataset consists of surface and upper air meteorological data required to run the dispersion model.

There are two input data processors that are regulatory components of the AERMOD modelling system:

- AERMET, a meteorological data pre-processor that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts; and
- AERMAP, a terrain data pre-processor that incorporates complex terrain using United States Geological Survey Digital Elevation Data.

7.2.1.3 Modelling Domain

The influence of the terrain will vary with the source height and position and the local meteorology. Table 7-2 gives an overview of meteorological parameters and basic setup options for the AERMOD model runs.

AERMOD's three models and required model inputs are described below:

- AERMET: calculates boundary layer parameters for input to AERMOD:
  - Model inputs: wind speed; wind direction; cover; ambient temperature; albedo; surface roughness; and Bowen ratio.
- AERMAP: calculates terrain heights and receptor grids for input to AERMOD:
  - Model inputs: DEM data [x, y, z]; design of receptor grid; and
  - Model outputs for AERMOD: [x,y,z] and hill height scale for each receptor.
- AERMOD: calculates temporally averaged air pollution concentrations at receptor locations for comparison to the relevant standard:

Table 7-2: Summary of Meteorological and AERMET Parameters Model Inputs.

Number of grids (spacing)	200 m
Number of grids points	121 x 121
Years of analysis	January 2016 to December 2018
Centre of analysis	Belfast (25.762778 S; 30.028056 E)
Meteorological grid domain	20 km (east-west) x 20 km (south-north)
Station Base Elevation	1753 m
MM5-Processed Grid Cell (Grid Cell Centre)	25.762778 S; 30.028056 E
Anemometer Height	14 m
Sectors	The surrounding area land use type was grassland

Albedo	0.28 (generated with the AERMOD Model – when the land use types are specified)
Surface Roughness	0.0725
Bowen Ratio	0.75
Terrain Option	Flat

8 Results

8.1 Background Climate and Air Quality

8.1.1 Receptors Environment

The proposed Project area is located within the Nkangala District Municipality (NDM), specifically in Ward 1 of the Emakhazeni Local Municipality (ELM). The nearest large settlements to the site are the town of Belfast (8 km) and its township of Siyathuthuka (15 km), both to the north of the proposed mine. The land use types in the area are mainly mining, residential and farming activities.

Former Exxaro Resource North Block Complex (NBC), now, UCD Glisa Mine owned by Universal Coal is about 1.2 km east of Belfast and less than 0.5 km south of Siyathuthuka (Figure 8-1). Seven active coal mines are in operation within a radius of 12 km. These are listed in Figure 8-1, along with their proximate distance from the proposed Project.

These receptors are locations where people work or reside, and may include hospitals, schools, day-care facilities, elderly housing and convalescent facilities (United States Environmental Protection Agency (USEPA, 2016).

These are areas where the occupants are more susceptible to the adverse effects of exposure to toxic chemicals, pesticides, and other pollutants. Human settlements where involuntary exposure is likely to occur are not exempted. The receptors and their proximate distances from the Project infrastructure are depicted in Figure 8-1.

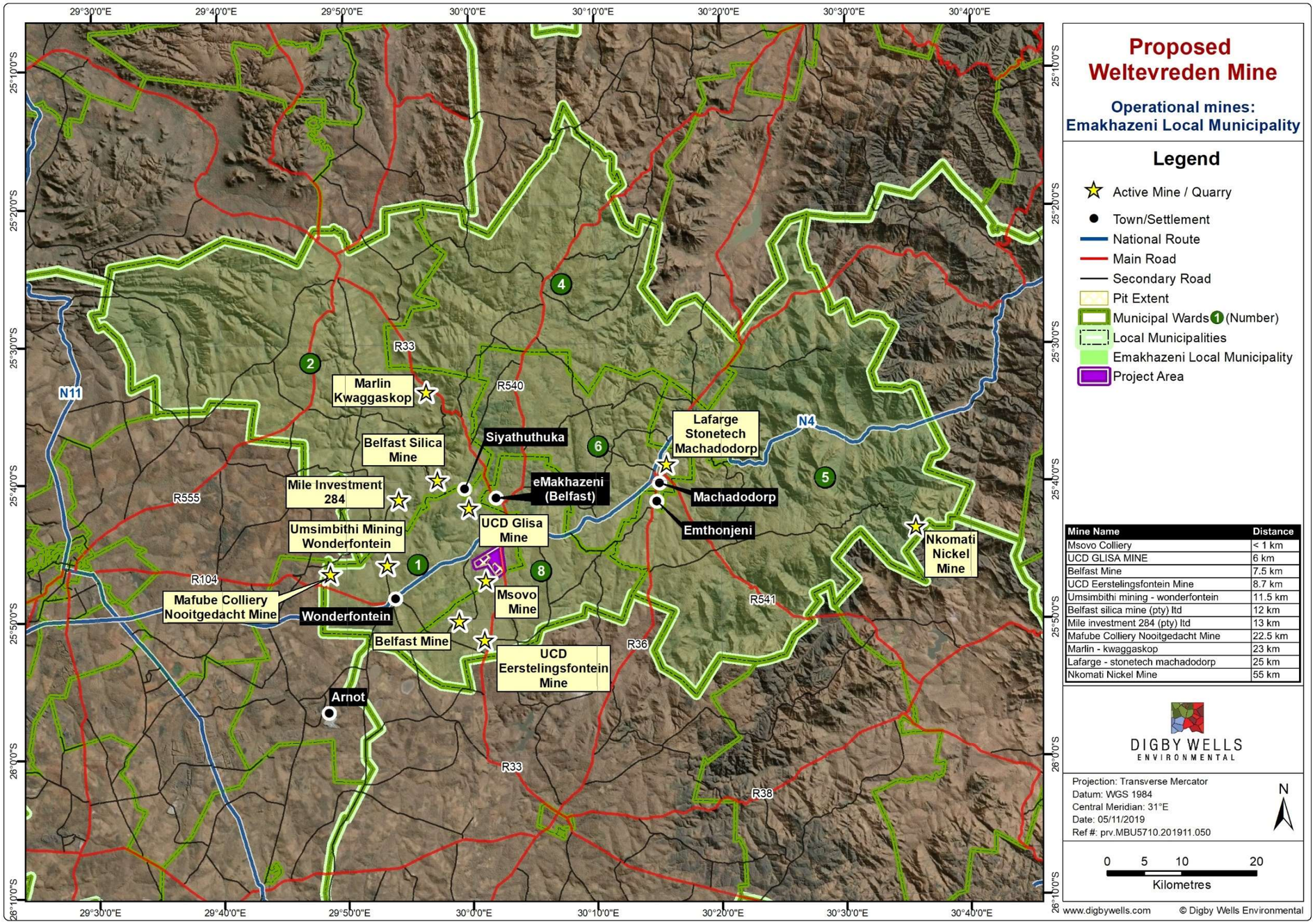

Figure 8-1: Project Area

8.1.2 General Climatic Description

Ambient air quality in this region of South Africa is strongly influenced by regional atmospheric movements, together with local climatic and meteorological conditions. There are distinct summer and winter weather patterns that affect the dispersal of pollutants in the atmosphere. In summer, unstable atmospheric conditions result in mixing of the atmosphere and rapid dispersion of pollutants. Summer rainfall also aids in removing pollutants through wet deposition. Precipitation reduces wind erosion potential by increasing the moisture content of exposed surface materials, this represents an effective mechanism for suppressing wind-blown dust. Rain-days are defined as days experiencing 0.1 mm or more rainfall (Stephenson *et al*.,1998).

In contrast, winter is characterised by atmospheric stability caused by a persistent high-pressure system over South Africa. This dominant high-pressure system results in subsidence, causing clear skies and a pronounced temperature inversion over interior of South Africa. This inversion layer traps pollutants from near surface sources in the lower atmosphere, which results in reduced dispersion and poorer air quality. Preston-Whyte and Tyson (1988) described the atmospheric conditions in the winter months as highly unfavourable for the dispersion of atmospheric pollutants.

Modelled meteorological data from Lakes Environmental (hereafter Lakes) for the period January 2016 to December 2018 encompassing parameters such as temperature, relative humidity, wind speed and direction for the Project area are discussed (Table 8-1).

8.1.2.1 Rainfall

The total monthly rainfall records (3 years average) are provided in Figure 8-2. Based on data for rainfall, the spring (September - November) and summer months, (December – February) received much of the annual rains (i.e. >86%) with November and December being the peak rainfall months, followed by autumn with 11%. Winter (June – August), received the least rainfall of 2%.

8.1.2.2 Temperature

The monthly temperatures for the Project site (3-year average) are presented in Table 8-1 and Figure 8-3. The data indicate that mean temperatures ranged between 8°C - 19°C. Ambient temperatures were higher during the summer months. The maximum temperatures (**in bold**) on the other hand ranged between 17°C - 31°C, depicted in Table 8-1.

8.1.2.3 Relative Humidity

The monthly relative humidity (3-year average) ranged between 64% and 72% throughout the whole year (Table 8-1 and Figure 8-3). Ravi *et al*., (2006)[3], investigated the effect of near surface air humidity on soil erodibility. Results show that the *threshold friction velocity* required for fine particulate matter to be airborne decreases with increasing values of relative humidity between about 40% and 65%, while above and below this range the threshold friction velocity increases with air humidity i.e. In air-dry soils (RH < 65%), the soils are too dry for the liquid-bridge bond to exist. However, with humidity conditions (RH > 65%) water condenses into liquid and form bridges between the soil grains and then the liquid-bridge bonding dominates, increasing the *threshold friction velocity*. The humidity is in the right range to inhibit erosion.

[3] Ravi, S., Zobeck, T. M., Over, T. M., Okin, G S., D'Odorico, P. (2006). On the effect of moisture bonding forces in air-dry soils on threshold frictional velocity of wind erosion. *Sedimentology*. 53, 597-609.

Table 8-1: Climate Statistics (Lakes 2016 - 2018)

Parameters	3-year average												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Max Temp. (◦C)	18	18	17	15	11	9	8	11	15	16	17	19	15
	28	26	26	23	19	17	17	22	26	26	28	31	28
Total Mon. Rain (mm)	161	183	114	29	5	3	6	20	51	110	225	250	1156
Rel. Hum. (%)	72	77	71	70	70	69	70	65	64	67	67	69	69

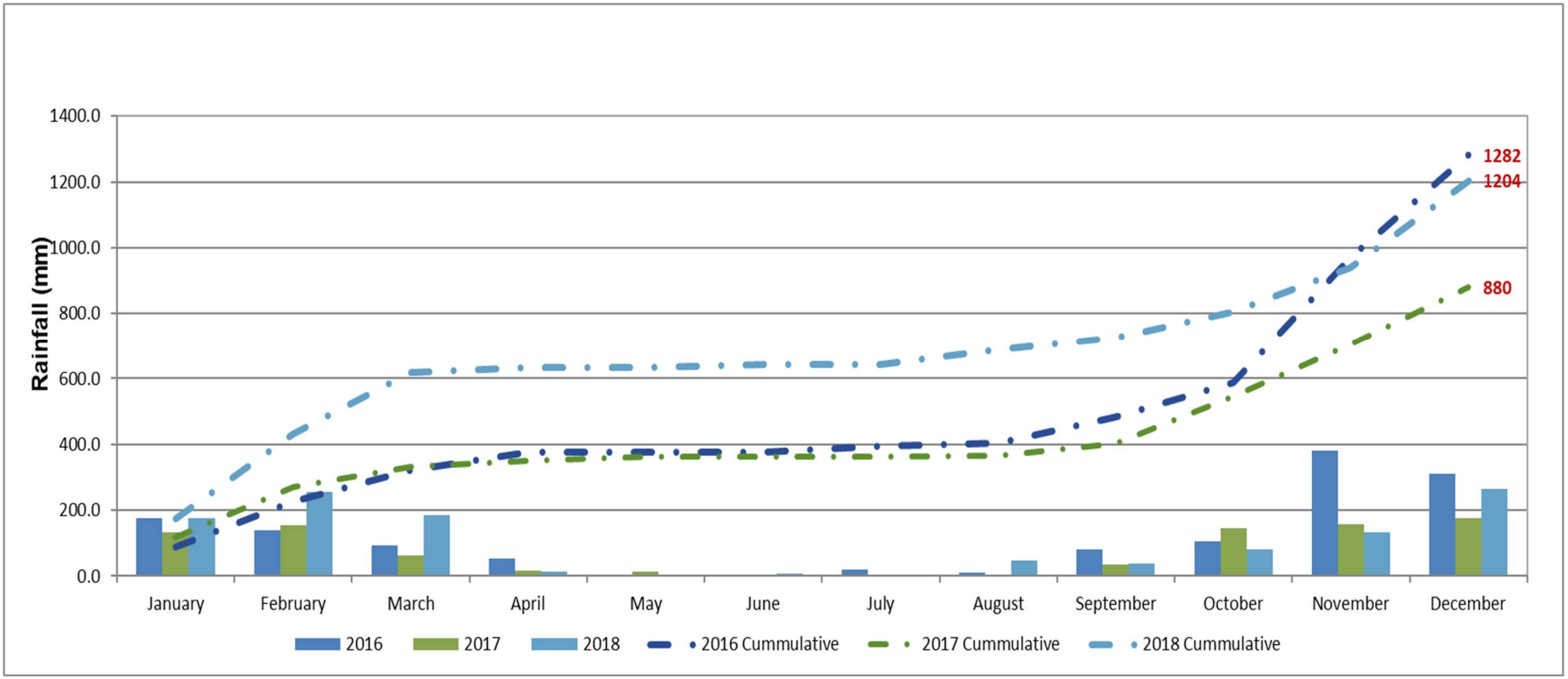

Figure 8-2: Rainfall (Lakes 2016 - 2018)

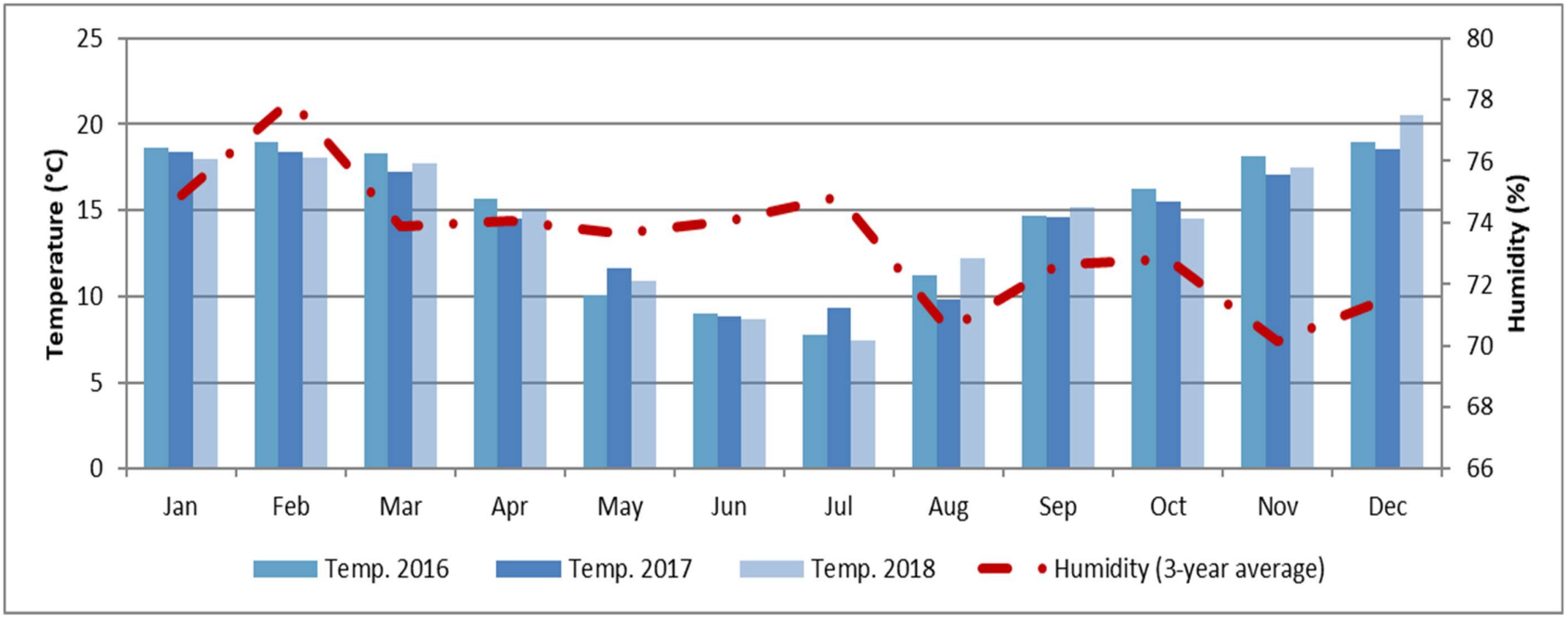

Figure 8-3: Mean Temperature and Relative Humidity (Lakes 2016 - 2018)

8.1.2.4 Wind Speed

The wind rose for the period 2016 – 2018 is depicted in Figure 8-4. The dominant winds are blowing from the east northeast (13%) and the northeast (12%). Secondary winds are blowing from northwest (9.8%) and west northwest (8.7%). Stronger winds, ≥ 5.4 m/s occurred some 13.6% of the time, with winds from the north western sector dominating this category. The average wind speed at the project site is 3.7 m/s and calm conditions (wind speeds <0.5 m/s) occurred for 1% of the time. The wind class frequency is shown in Figure 8-5.

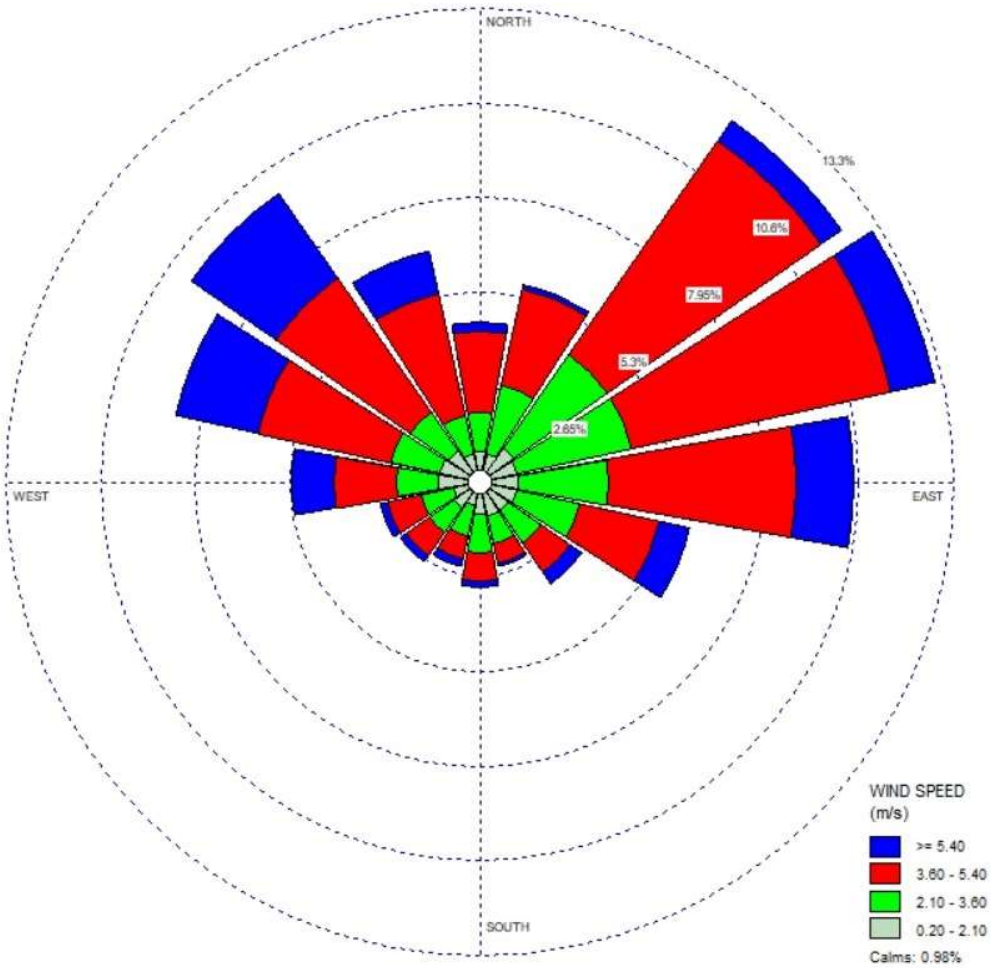

Figure 8-4: Surface wind rose (Lakes 2016 - 2018)

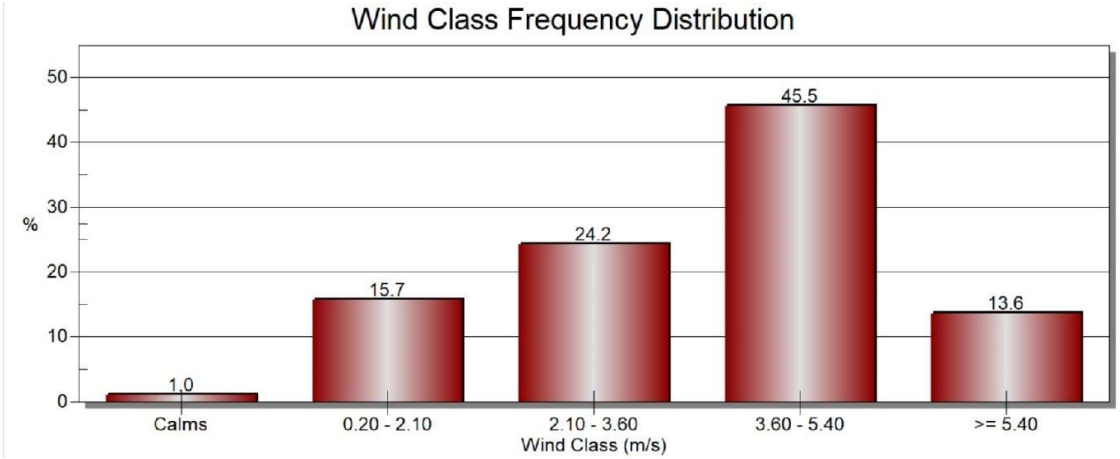

Figure 8-5: Wind Class Frequency (Lakes 2016 - 2018)

8.1.3 Existing Air Quality

8.1.3.1 Fine Particulate Matter and Dust Fall

The real-time monitor set up in August 2019 in the Project area collected fine particulate matter PM_{10} and $PM_{2.5}$. In total, nearly three months of data were obtained. Monitoring of these criteria pollutants will ensure background levels are established prior to the commencement of mining. The airborne concentration of PM_{10} and $PM_{2.5}$ measured in the Project area are presented in Figure 8-6 and Figure 8-7. The ambient PM_{10} and $PM_{2.5}$ levels in the Project area were below the South African standards, with no exceedance recorded.

8.1.3.2 Gaseous Pollutants

In addition to the above mentioned, data collection for the other criteria gaseous pollutants, such as carbon dioxide (CO), ozone (O_3) and NO_2 have been completed. Results show that CO and NO_2 concentrations were below the standard throughout the sampling period (Figure 8-8 and Figure 8-10). This is not the case with O_3, 51 days recorded exceedance during the three months sampling period (Figure 8-9).

Monitoring of these pollutants prior to the commencement of mining is invaluable as this will represent a reference point to which future perturbations can be compared.

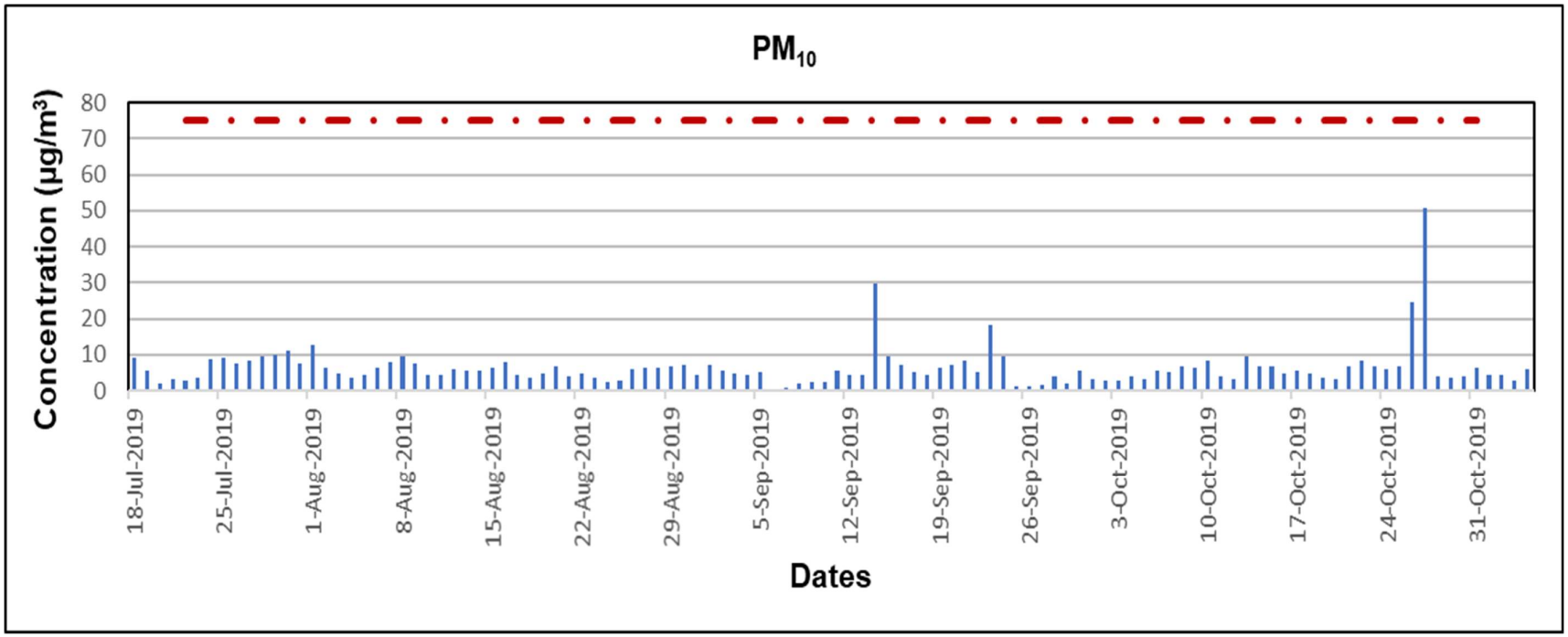

Figure 8-6: Ambient PM_{10} Concentrations

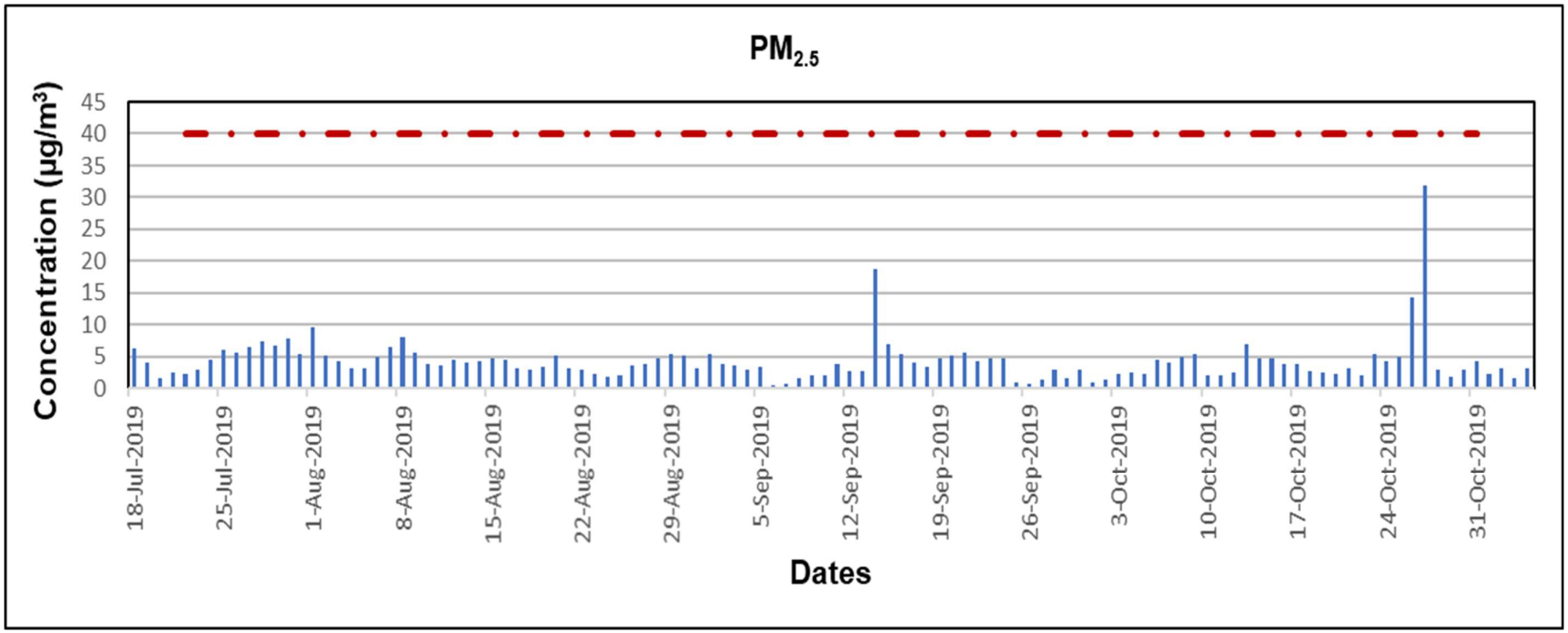

Figure 8-7: Ambient $PM_{2.5}$ Concentrations

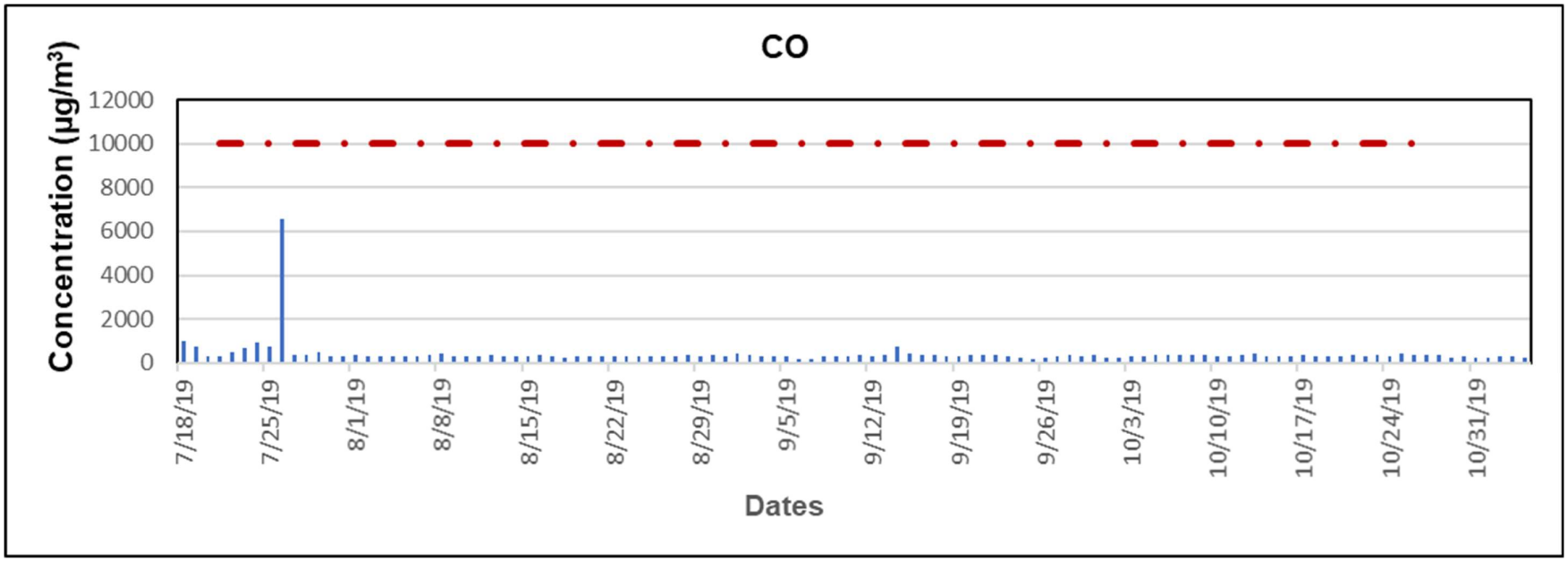

Figure 8-8: Ambient CO Concentrations

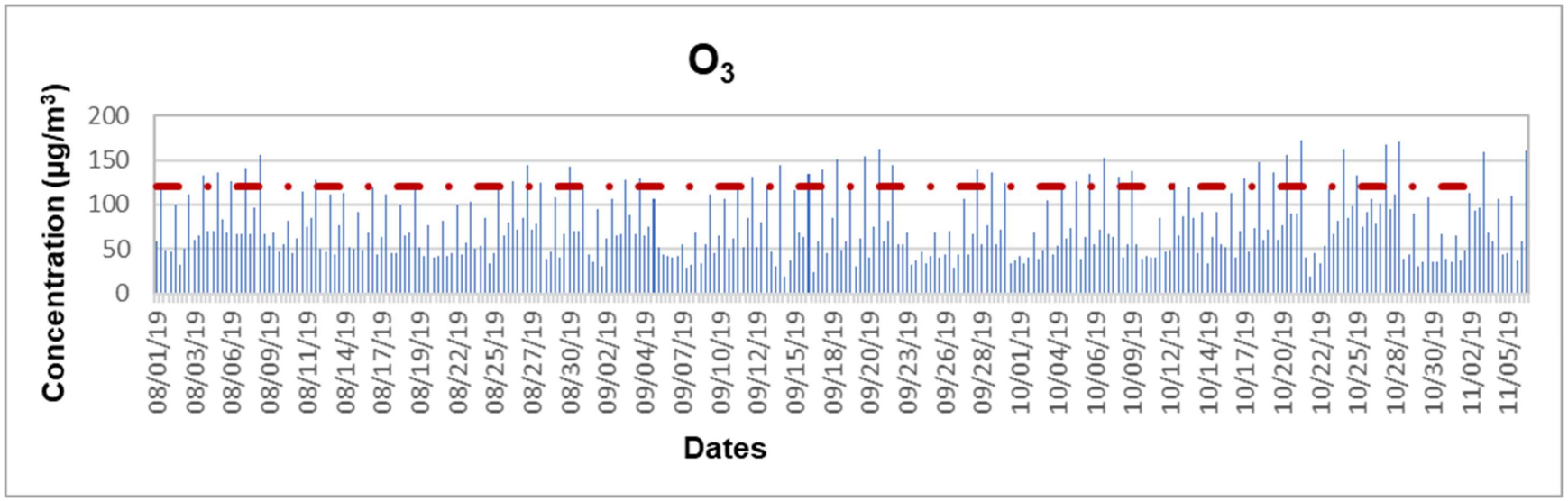

Figure 8-9: Ambient O_3 Concentrations

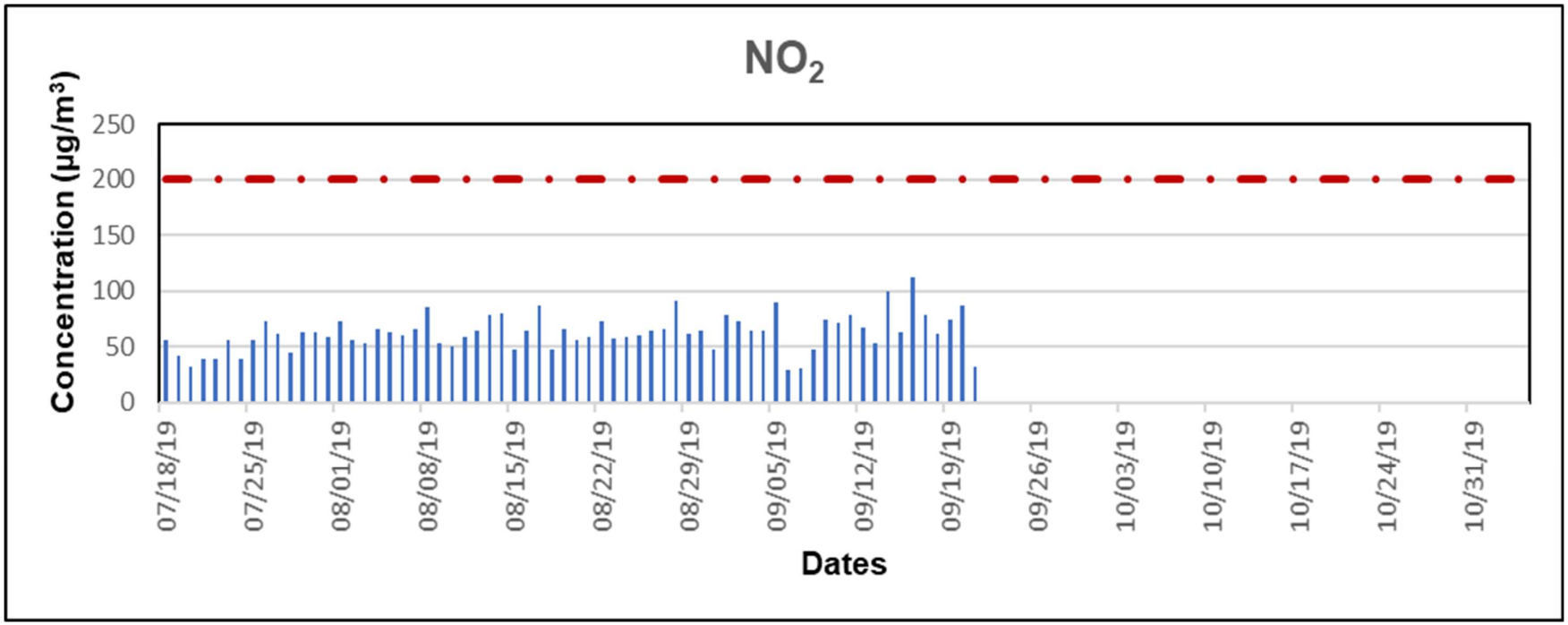

Figure 8-10: Ambient NO_2 Concentrations

8.2 Dispersion Model Simulation Results

The model results consist of a graphical representation of GLC (in µg/m^3) for the different pollutants, and dust deposition rates (Total Suspended Particulate – TSP) are presented in mg/m^2/day. The daily averages were calculated as the 4th highest value (99th percentile). Annual averages were shown as the 1st highest value (100th percentile).

8.2.1 Isopleth Plots and Evaluation of Modelling Results

8.2.1.1 Predicted GLC for PM2.5

The GLC of $PM_{2.5}$ predicted over a 24-hour averaging period for the operational phase returned simulation isopleths that are shown in Figure 8-11 ($PM_{2.5}$ daily) and Figure 8-12 ($PM_{2.5}$ annual).

The model simulations show the worst-case scenario (assuming no mitigation measures were put in place at the mine). The predicted exceedances of the 24-hour standard of 40 µg/m³ will occur within the Project boundary, extending out in the eastern and western directions. The GLC at Siyathuthuka and Belfast, the nearest sensitive receptors will be lower than the standard (Table 8-2). The annual GLC of $PM_{2.5}$ predicted will not exceed standard outside the Project boundary. However, an area onsite will experience exceedance of the annual limit (25 µg/m³).

8.2.1.2 Predicted GLC for PM10

The 24-hour GLC of PM_{10} predicted for the proposed Project returned isopleths shown in Figure 8-13 (PM_{10} daily) and Figure 8-14 (PM_{10} annual).

Areas where exceedance of the South African 24-hour standard (75 µg/m³) will occurred extends outside the Project boundary to the east, south and west respectively. This is without mitigation measures in place. The GLC predicted for Siyathuthuka and Belfast were below the standard (Table 8-2). The predicted annual GLC showed that areas where exceedances will occur are within the Project boundary (Figure 8-14). This will fall under the Occupational Hygiene regulation and will not be discussed in this report. The annual GLC predicted at Siyathuthuka and Belfast were all below the South African standard.

8.2.1.3 TSP Predicted Impacts

The predicted dust deposition rates (represented as TSP), from the model simulation are shown in Figure 8-15 and Figure 8-16. The predicted dust deposition rates confirm that the non-residential limit of 1,200 mg/m^2/day will be exceeded onsite and outside the Project boundary without mitigation measures in place. However, with mitigation measures in place, exceedances will be limited to the Project boundary. The predicted exposure levels at Siyathuthuka and Belfast were within the residential limit of 600 mg/m^2/day (Table 8-2).

Table 8-2: Predicted Concentrations of PM_{10}, $PM_{2.5}$ and Dust Deposition Rates at Selected Receptors

Pollutants	Averaging Period	South Africa Air Quality Standard (µg/m³)	Predicted Ground Level Concentration (µg/m³)	
			Siyathuthuka	Belfast
PM_{10} (No Mitigation)	Daily	50[1]	26	48
	Annual	20[1]	1.1	1.6
$PM_{2.5}$ (No Mitigation)	Daily	25[1]	5	9.6
	Annual	10[1]	1.1	1.6
Dust Deposition Rates (mg/m²/day)				
Dust (No Mitigation)	Monthly	Residential (600[2]) Non-residential (1200[2])	38	86
Dust (With Mitigation)			4.4	1.1

1. South African National Ambient Air Quality Standards, 2009;2012
2. South African National Dust Control Regulation, 2013 (NDCS)

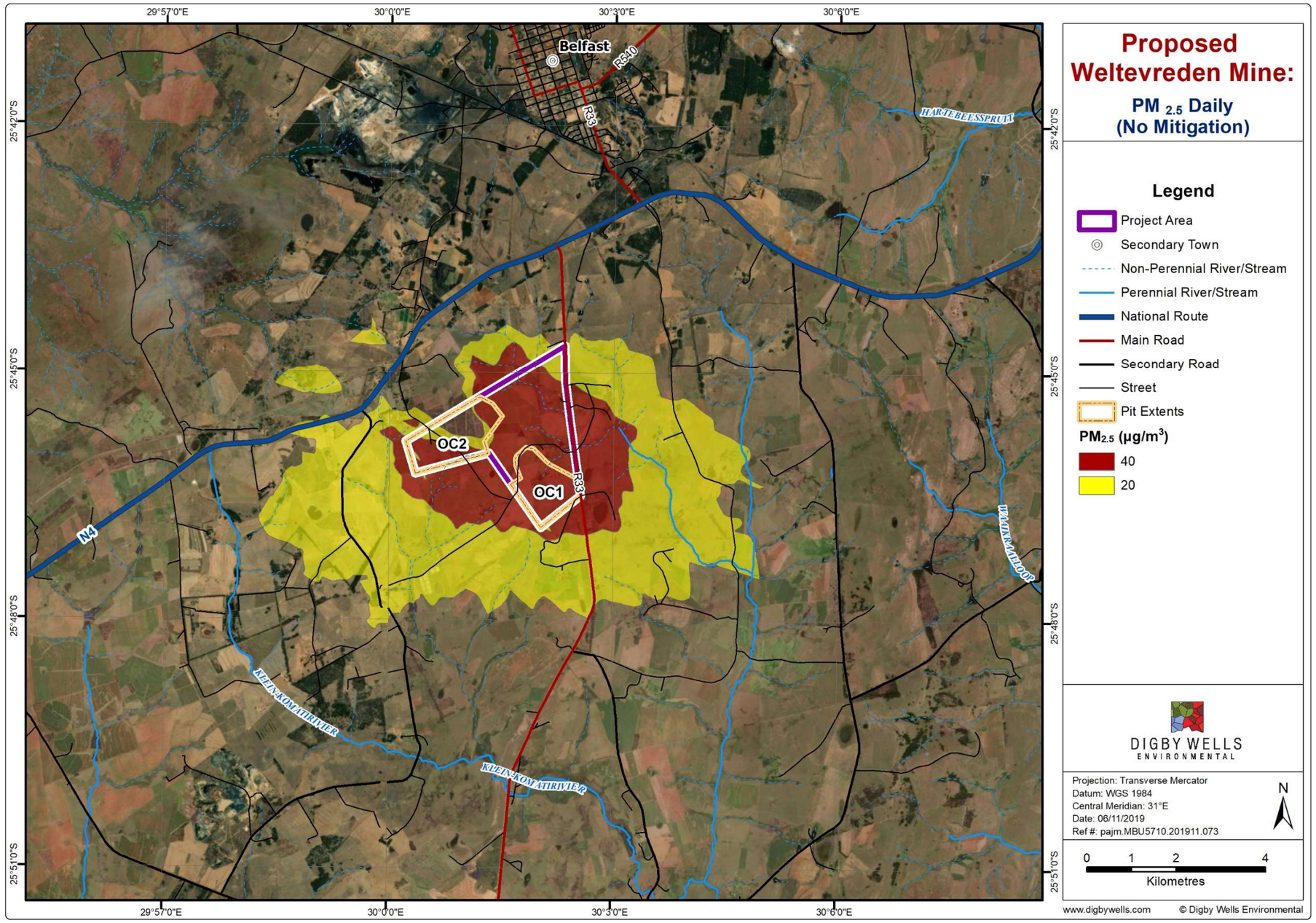

Figure 8-11: Predicted 4th highest (99th percentile) daily $PM_{2.5}$ Concentrations (µg/m³)

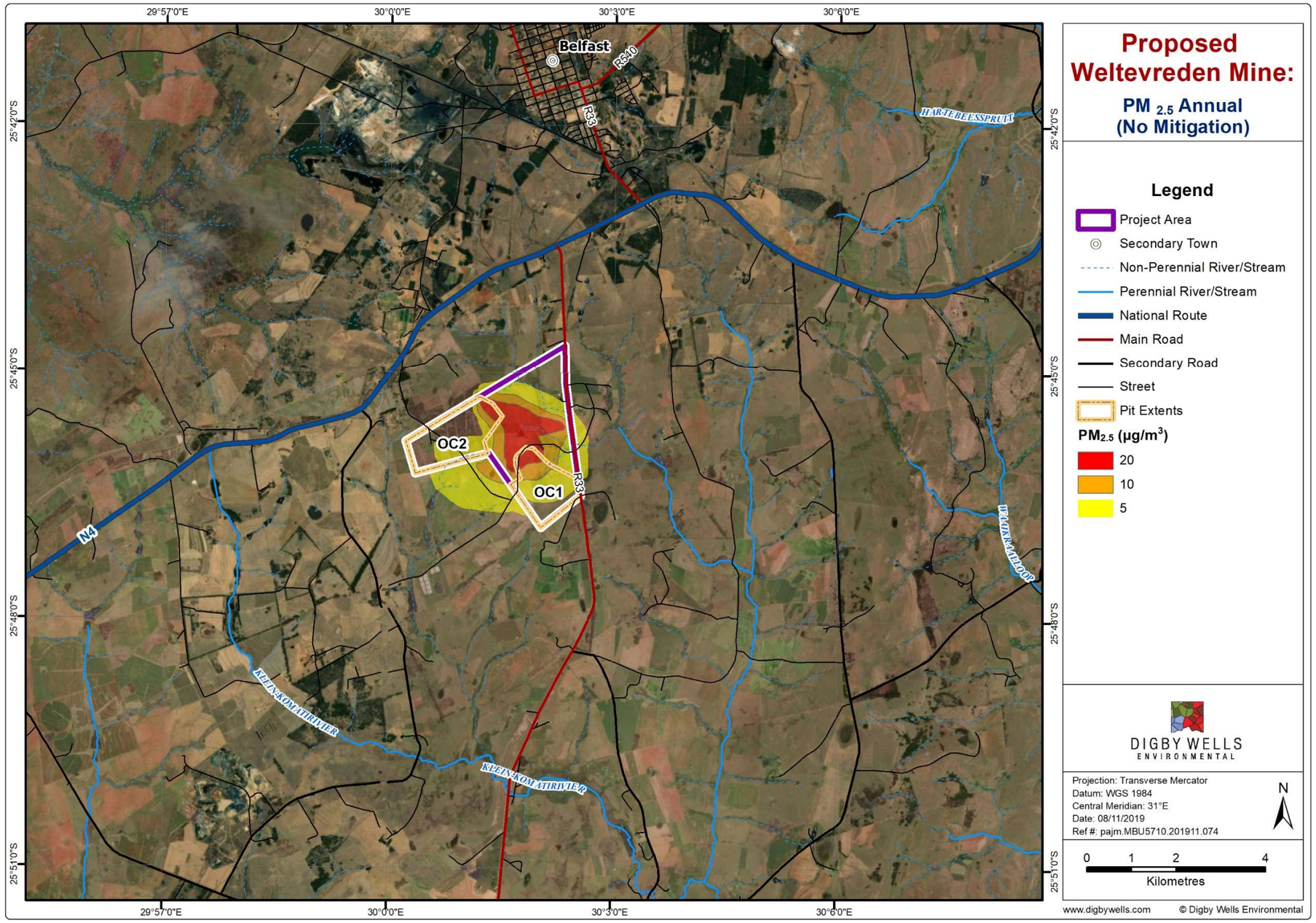

Figure 8-12: Predicted 1st highest (100th percentile) Annual PM2.5 Annual Concentrations (µg/m³)

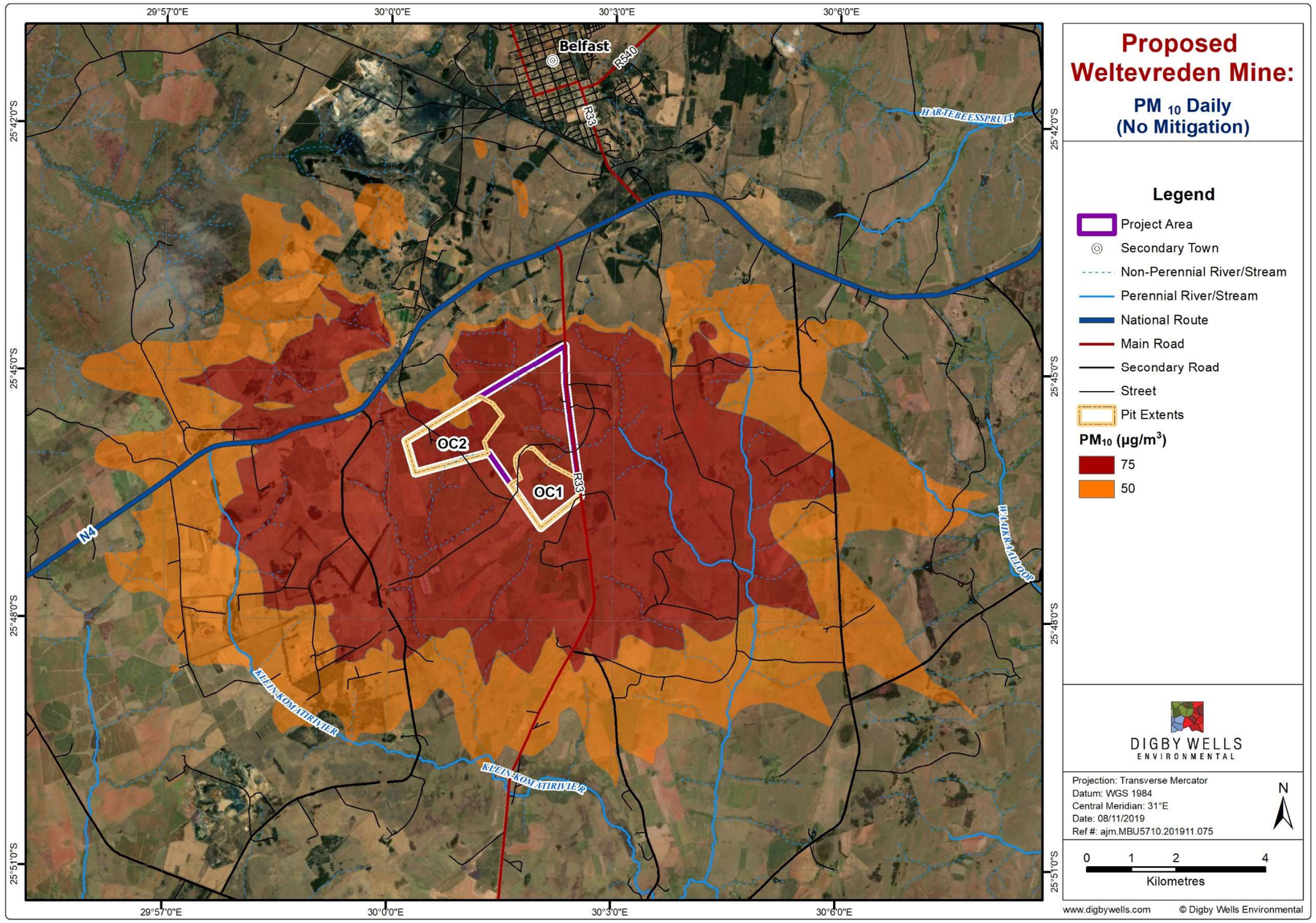

Figure 8-13: Predicted 4th highest (99th percentile) daily PM_{10} Concentrations (µg/m³)

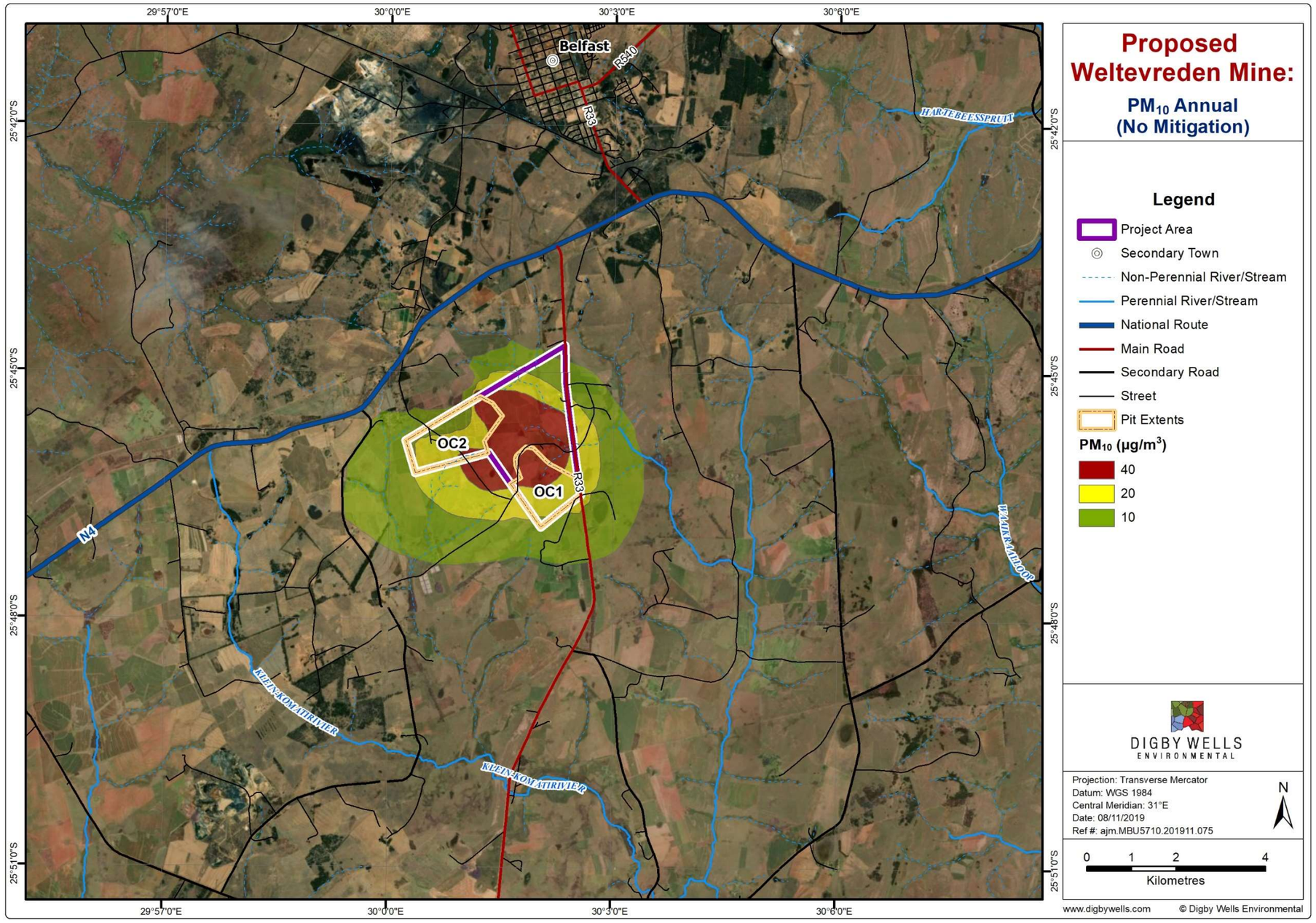

Figure 8-14: Predicted 1st highest (100th percentile) Annual PM_{10} Concentrations (µg/m³)

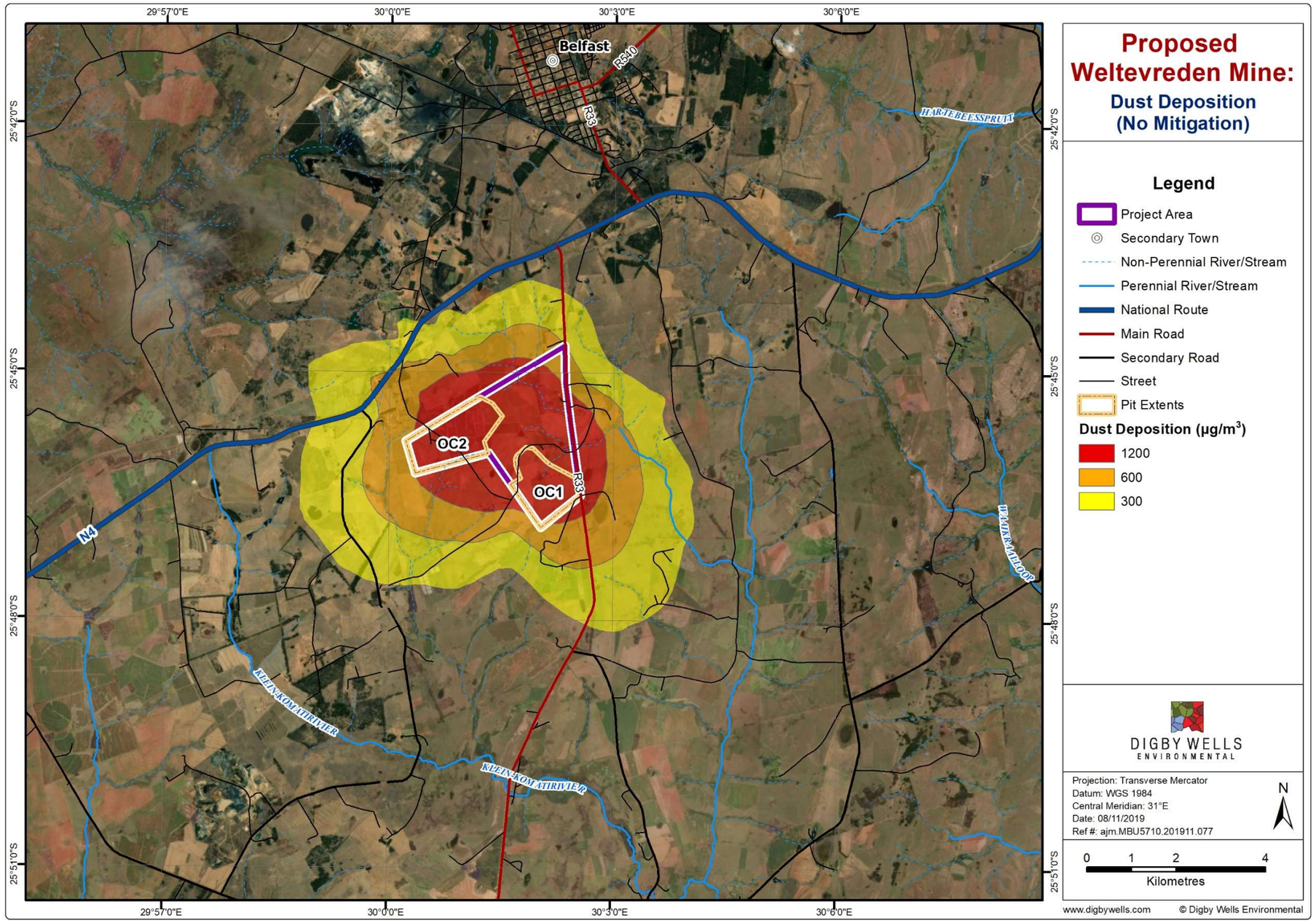

Figure 8-15: Predicted (100th percentile) Monthly TSP Deposition Rates (mg/m²/day) No Mitigation

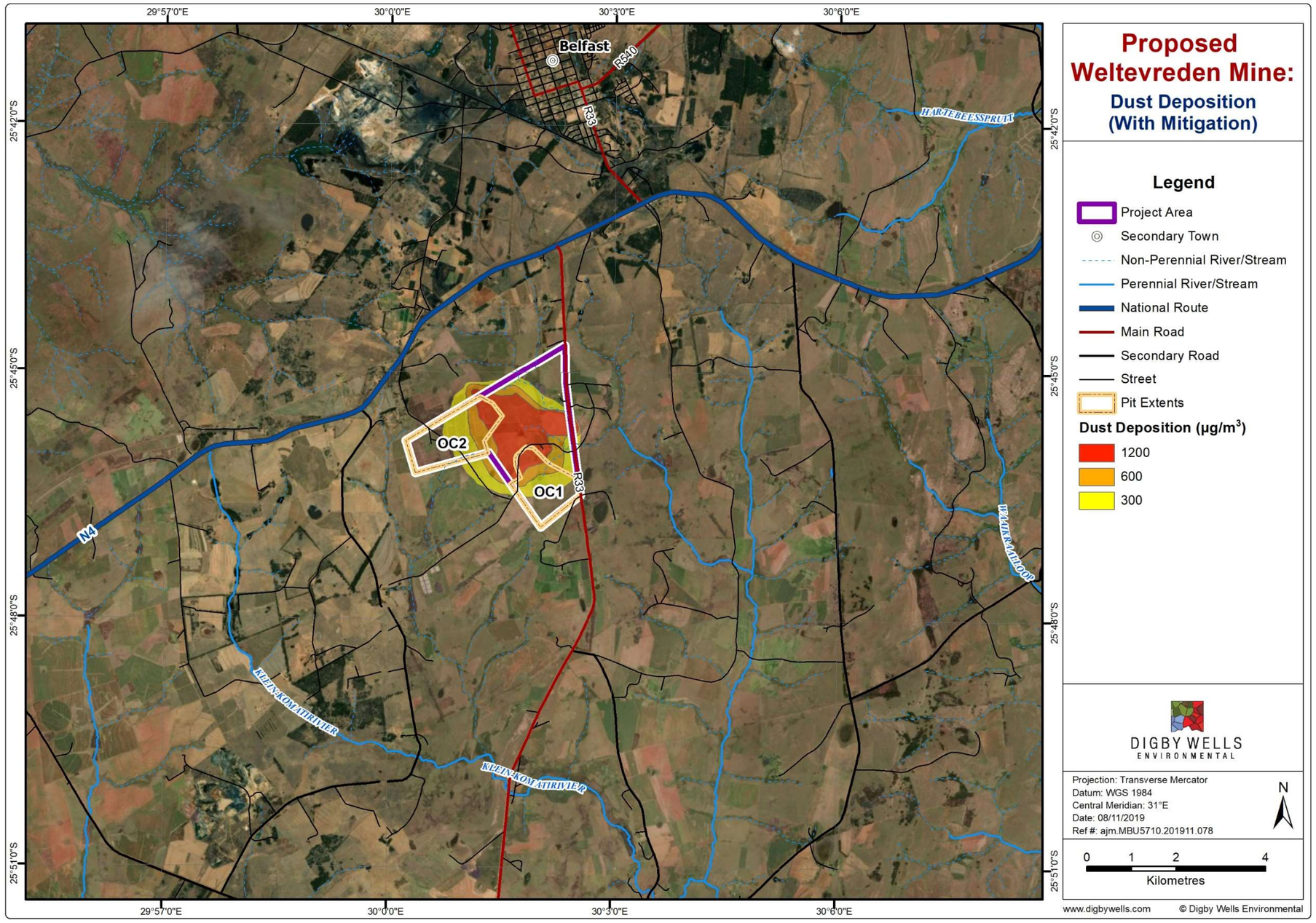

Figure 8-16: Predicted (100th percentile) Monthly TSP Deposition Rates (mg/m²/day) With Mitigation

9 Discussions

The potential impacts predicted for the Project have been appraised using the predicted GLC of pollutants from emission sources.

9.1 Findings

The results presented represent the worst-case scenario, i.e. without mitigation measures in place. The main findings of this air quality study are summarised as follows:

- The predicted exceedances of the 24-hour standard of 40 µg/m³ will occur within the Project boundary, extending out in the eastern and western directions. The GLC at Siyathuthuka and Belfast, the nearest receptors will be lower than the standard. The annual GLC of $PM_{2.5}$ predicted will not exceed standard outside the Project boundary. However, an area onsite will experience exceedance of the annual limit (25 µg/m³). It is believed that with mitigation measure in place, emissions will be contained, and ambient concentrations will be reduced below regulatory limit values.
- Areas where exceedance of the South African 24-hour standard (75 µg/m³) will occurred extends outside the Project boundary to the east, south and west respectively. This is without mitigation measures in place. The GLC predicted for Siyathuthuka and Belfast were below the standard. The predicted annual GLC showed that areas where exceedances will occur are within the Project boundary. This will fall under the Occupational Hygiene regulation and will not be discussed in this report. The annual GLC predicted at Siyathuthuka and Belfast were all below the South African standard.
- The predicted dust deposition rates confirm that the non-residential limit of 1,200 mg/m^2/day will be exceeded onsite and outside the Project boundary without mitigation measures in place. However, with mitigation measures factored into the day to day operation at the mine, exceedances will be limited to the Project boundary. The predicted exposure levels at the Siyathuthuka and Belfast were within the residential limit of 600 mg/m^2/day.

Considering the low levels of PM_{10} and $PM_{2.5}$ measured in the vicinity of the proposed Project, it is not anticipated that cumulative levels as a result of the operational phase of the Project will exceed regulatory limit values.

10 Impact Assessment Ranking

The potential impacts from the proposed Project have been assessed based on the severity predicted on-site and at sensitive receptor(s). This culminates in a significance rating which identifies the most important impacts that require mitigation and/or management.

Based on international guidelines and South African legislation, the following criteria were considered when examining potentially significant impacts:

- Nature of impacts (direct / indirect, positive / negative);
- Duration (short / medium / long-term, permanent (irreversible) / temporary (reversible), frequent / seldom);
- Extent (geographical area, size of affected population / habitat / species);
- Intensity (minimal, severe, replaceable / irreplaceable);
- Probability (high / medium / low probability); and
- Possibility to mitigate, avoid or offset significant adverse impacts.

Details of the impact assessment methodology used to determine the significance of physical, bio-physical and socio-economic impacts are provided below.

The significance rating process follows the established impact / risk assessment formula:

Significance = Consequence x Probability x Nature

Where

Consequence = Intensity + Extent + Duration

And

Probability = Likelihood of an impact occurring

And

Nature = Positive (+1) or negative (-1) impact

Note: In the formula for calculating consequence, the type of impact is multiplied by +1 for positive impacts and -1 for negative impacts

The matrix calculates the rating out of 147, whereby Intensity, Extent, Duration and Probability are each rated out of seven as indicated in Table 10-1. The weight assigned to the various parameters is then multiplied by +1 for positive and -1 for negative impacts. Impacts are rated prior to mitigation and again after consideration of the mitigation measure proposed in the Environmental Management Plan Report (EMPr). The significance of an impact is then determined and categorised into one of eight categories, as indicated in Table 10-2, which is

extracted from Table 10-1. The description of the significance ratings is discussed in Table 10-3.

It is important to note that the pre-mitigation rating takes into consideration the activity as proposed, i.e. there may already be certain types of mitigation measures included in the design (for example due to legal requirements). If the potential impact is still considered too high, additional mitigation measures are proposed.

Table 10-1: Impact Assessment Parameter Ratings

RATING	INTENSITY/REPLACABILITY		EXTENT	DURATION/REVERSIBILITY	PROBABILITY
	Negative impacts	Positive impacts			
7	Irreplaceable damage to highly valued items of great natural or social significance or complete breakdown of natural and / or social order.	Noticeable, on-going natural and / or social benefits which have improved the overall conditions of the baseline.	International The effect will occur across international borders.	Permanent: The impact is irreversible, even with management, and will remain after the life of the project.	Definite: There are sound scientific reasons to expect that the impact will definitely occur. >80% probability.
6	Irreplaceable damage to highly valued items of natural or social significance or breakdown of natural and / or social order.	Great improvement to the overall conditions of a large percentage of the baseline.	National Will affect the entire country.	Beyond project life: The impact will remain for some time after the life of the project and is potentially irreversible even with management.	Almost certain / Highly probable: It is most likely that the impact will occur. <80% probability.
5	Very serious widespread natural and / or social baseline changes. Irreparable damage to highly valued items.	On-going and widespread benefits to local communities and natural features of the landscape.	Province/ Region Will affect the entire province or region.	Project Life (>15 years): The impact will cease after the operational life span of the project and can be reversed with sufficient management.	Likely: The impact may occur. <65% probability.

RATING	INTENSITY/REPLACABILITY		EXTENT	DURATION/REVERSIBILITY	PROBABILITY
	Negative impacts	**Positive impacts**			
4	On-going serious natural and / or social issues. Significant changes to structures / items of natural or social significance.	Average to intense natural and / or social benefits to some elements of the baseline.	Municipal Area Will affect the whole municipal area.	Long term: 6-15 years and impact can be reversed with management.	Probable: Has occurred here or elsewhere and could therefore occur. <50% probability.
3	On-going natural and / or social issues. Discernible changes to natural or social baseline.	Average, on-going positive benefits, not widespread but felt by some elements of the baseline.	Local Local extending only as far as the development site area.	Medium term: 1-5 years and impact can be reversed with minimal management.	Unlikely: Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur. <25% probability.
2	Minor natural and / or social impacts which are mostly replaceable. Very little change to the baseline.	Low positive impacts experience by a small percentage of the baseline.	Limited Limited to the site and its immediate surroundings.	Short term: Less than 1 year and is reversible.	Rare / improbable: Conceivable, but only in extreme circumstances. The possibility of the impact materialising is very low as a result of design, historic experience or implementation of adequate mitigation measures. <10% probability.
1	Minimal natural and / or social impacts, low-level replaceable damage with no change to the baseline.	Some low-level natural and / or social benefits felt by a very small percentage of the baseline.	Very limited Limited to specific isolated parts of the site.	Immediate: Less than 1 month and is completely reversible without management.	Highly unlikely / None: Expected never to happen. <1% probability.

Table 10-2: Probability/Consequence Matrix

Probability	Significance																																					
7	-147	-140	-133	-126	-119	-112	-105	-98	-91	-84	-77	-70	-63	-56	-49	-42	-35	-28	-21	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140	147
6	-126	-120	-114	-108	-102	-96	-90	-84	-78	-72	-66	-60	-54	-48	-42	-36	-30	-24	-18	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120	126
5	-105	-100	-95	-90	-85	-80	-75	-70	-65	-60	-55	-50	-45	-40	-35	-30	-25	-20	-15	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105
4	-84	-80	-76	-72	-68	-64	-60	-56	-52	-48	-44	-40	-36	-32	-28	-24	-20	-16	-12	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84
3	-63	-60	-57	-54	-51	-48	-45	-42	-39	-36	-33	-30	-27	-24	-21	-18	-15	-12	-9	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63
2	-42	-40	-38	-36	-34	-32	-30	-28	-26	-24	-22	-20	-18	-16	-14	-12	-10	-8	-6	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42
1	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	Consequence																																					

Table 10-3: Significance Rating Description

Score	Description	Rating
109 to 147	A very beneficial impact that may be sufficient by itself to justify implementation of the project. The impact may result in permanent positive change	Substantial (positive)
73 to 108	A beneficial impact which may help to justify the implementation of the project. These impacts would be considered by society as constituting a major and usually a long-term positive change to the (natural and / or social) environment	Major (positive)
36 to 72	An positive impact. These impacts will usually result in positive medium to long-term effect on the natural and / or social environment	Minor (positive)
3 to 35	A small positive impact. The impact will result in medium to short term effects on the natural and / or social environment	Negligible (positive)
-3 to -35	An acceptable negative impact for which mitigation is desirable. The impact by itself is insufficient even in combination with other low impacts to prevent the development being approved. These impacts will result in negative medium to short term effects on the natural and / or social environment	Negligible (negative)
-36 to -72	A minor negative impact requires mitigation. The impact is insufficient by itself to prevent the implementation of the project but which in conjunction with other impacts may prevent its implementation. These impacts will usually result in negative medium to long-term effect on the natural and / or social environment	Minor (negative)
-73 to -108	A moderate negative impact may prevent the implementation of the project. These impacts would be considered as constituting a major and usually a long-term change to the (natural and / or social) environment and result in severe changes.	Major (negative)
-109 to -147	A major negative impact may be sufficient by itself to prevent implementation of the project. The impact may result in permanent change. Very often these impacts are immitigable and usually result in very severe effects. The impacts are likely to be irreversible and/or irreplaceable.	Substantial (negative)

10.1 Potential Impacts

The sections below provide the description of the impacts during the construction, operation and decommissioning phases of the Project. The construction and decommissioning phases are usually short-term and conducted in phase, with negligible impacts on the ambient air quality. Despite the aforementioned, these were rated in this section. The operational phase activities are grouped together and assessed, rather than individually.

10.1.1 Construction Phase

10.1.1.1 Impact Description

Construction of Project infrastructure will occur in phases and will be short-term in nature. Therefore, the associated impacts will be negligible. As part of the Construction Phase, the following activities are identified that may impact on the ambient air quality:

- Site clearing;
- Access and haul road construction;
- Infrastructure construction;
- Topsoil stockpiling; and
- Loading, transport, tipping and spreading of materials.

These activities associated with this phase will result in the generation of fugitive dust comprising of TSP, PM_{10} and $PM_{2.5}$, especially from dirt roads and open surfaces which are traversed during the construction activities. Also, excavation, loading and tipping of construction material will lead to dust generation. Although gaseous emissions will be generated from off-road vehicles, emissions will disperse faster due to the duration and nature of each activity. The different activities will occur in phases, will be short-term and localised in nature, and will have low impacts on the ambient air quality.

The management objective is to ensure that emissions at on-site and off-site locations are not in exceedance of the regulatory limits for the protection of the environment, human health and wellbeing. Mitigation measures will be implemented to ensure that emissions remain below limit values and in compliance with the relevant standards (Table 10-4).

10.1.1.2 Impact Ratings

The potential impact from construction activities on air quality are provided in Table 10-4.

Table 10-4: Significance Ratings for Site Clearing, Cccess Road and Haul Road Construction, Infrastructure Construction, Topsoil Stockpiling/Transport, Tipping and Spreading of Materials

Activity and Interaction: Site Clearing, Access Road and Haul Road Construction, Infrastructure Construction, Transport, Tipping and Spreading of Materials			
Impact Description: Nuisance and reduction in ambient air quality			
Prior to Mitigation / Management			
Dimension	**Rating**	**Motivation**	**Significance**
Duration	Short-Term (2)	Impact will occur for the duration of the activity	(30) Negligible (negative)
Extent	Limited (2)	Exposure extent will be confined to the vicinity of the activity, but only to a limited degree	
Intensity	Minor (2)	Very little change to baseline environment	
Probability	Likely (5)	Impact may occur	
Nature	Negative		
Mitigation / Management Actions			
▪ Apply wetting agents, dust suppressant or binders on exposed areas (including excavated stockpiled material and on dirt roads); ▪ Enforce adherence to set vehicle speed limits; ▪ Conduct activities judiciously during windy days (≥5.4 m/s); and ▪ Minimise the drop heights when loading, offloading and tipping material.			
Post- Mitigation			
Dimension	**Rating**	**Motivation**	**Significance**
Duration	Short-Term (2)	Impact will occur for the duration of the activity	(5) Negligible (negative)
Extent	Very limited (1)	Limited to specific activity	
Intensity	Low (1)	Impacts will be low after mitigation measures are applied	
Probability	Rare (2)	Conceivable, but only in extreme circumstances after mitigations are applied	
Nature	Negative		

10.1.2 Operational Phase

10.1.2.1 Impact Description

As part of the Operational Phase, impacts on the ambient air quality are anticipated from the following activities:

- Open pit establishment;
- Removal of rock (blasting);
- Stockpiling (rock dumps, soils, ROM, discard dump) establishment and operation;
- Storage, handling and treatment of hazardous products (including fuel, explosives and oil) and waste;
- Material handling processes;
- Hauling of ore and discard waste;
- Crushing and screening;
- Wind erosion from storage piles and exposed areas; and
- Generator sets.

The model predictions have showed that exceedance of the regulatory limits will occur within and outside the Project area without mitigation measures in place. Anticipated pollutants include TSP, PM_{10} and $PM_{2.5}$. Mitigation measures will be implemented (Table 10-5), to ensure that emissions remain within limits and in compliance with the relevant standards.

10.1.2.2 Impact Ratings

The potential impact on air quality from operational activities is provided in Table 10-5.

Table 10-5: Significance Ratings for Open Pit Establishment, Removal of Rock, Stockpiling, Operating Processing Plant, Storage and Handling of Hazardous Substances, Material Handing, Hauling of Ore and Discard Waste, Crushing and Screening, Wind Erosion, and Generator Sets

Activity and Interaction: Open Pit Establishment, Removal of Rock, Stockpiling, Operating Processing Plant, Material Handing, Hauling of Ore and Discard Waste, Crushing and Screening, Wind Erosion, and Generator Sets			
Impact Description: Nuisance and potential health effects from exposure to fine particulate matter, gases and volatile			
Prior to Mitigation / Management			
Dimension	**Rating**	**Motivation**	**Significance**
Duration	Project life (5)	Impacts will occur for the project life	

Activity and Interaction: Open Pit Establishment, Removal of Rock, Stockpiling, Operating Processing Plant, Material Handing, Hauling of Ore and Discard Waste, Crushing and Screening, Wind Erosion, and Generator Sets			
Extent	Local (4)	Impacts will extend outside the Project boundary	(78) Major (negative)
Intensity	Serious (4)	Significant impacts from emissions	
Probability	Almost Certain (6)	Almost certain that impacts will occur	
Nature	Negative		
Mitigation / Management Actions			
▪ Apply wetting agents, dust suppressant or binders on the dirt roads; ▪ Construct surfaces of haul roads from lateritic soils and avoid fine/colloidal (e.g. clays and silts) materials; ▪ Vegetate exposed areas as soon as practicably possible; ▪ Enclose the crusher, screens, transfer and discharge points and conveyors; ▪ The area of disturbance shall always be kept to a minimum and no unnecessary stripping must occur, especially on windy days (wind speed ≥ 5.4 m/s); ▪ Set maximum vehicle speed limits on site and enforce these limits; ▪ Ensure emergency generators are operated at optimal conditions; and ▪ Minimise the drop heights when loading and unloading material onto trucks and at tipping points.			
Post- Mitigation			
Dimension	**Rating**	**Motivation**	**Significance**
Duration	Project life (5)	Impacts will occur for the for the project life	(27) Negligible (negative)
Extent	Limited (2)	The impact footprint will be limited to a small footprint within the Project boundary after mitigation	
Intensity	Minor (2)	Minor impact anticipated after mitigation measures are applied	
Probability	Unlikely (3)	Impact is unlikely to occur after mitigations are applied.	
Nature	Negative		

10.1.3 Decommissioning Phase

10.1.3.1 Impact Description

As part of the Decommissioning Phase the following activities have been identified that may impact on the ambient air quality of the study area; i.e. increasing the level of pollutants in the atmosphere (Table 10-6):

- Demolition and removal of all infrastructure, including transporting materials off site; and
- Rehabilitation, including spreading of soil, re-vegetation and profiling or contouring.

Rehabilitation will be on-going and carried out concurrently with the day to day operation of the mine, while the final rehabilitation will occur after the end of the operational life. During this activity, transporting and handling of topsoil and capping material for the final rehabilitation will occur. The impacts on the local ambient air quality during the decommissioning phase will be lower than those associated with the construction phase due to efforts in rehabilitating the Project site concurrently. Any implication this phase may have on the ambient air quality of the area will be short-term, localised and negligible. Demolition and rehabilitation will be conducted in phases to minimise dust generation on site. Anticipated impacts will be short-term and negligible. Mitigation measures will be implemented to ensure that emissions remain below limit values and the mine remains in compliance with relevant standards (Table 10-6).

10.1.3.2 Impact Ratings

The potential impact on air quality from decommissioning and rehabilitation activities is provided in Table 10-6.

Table 10-6: Significance Ratings for Rehabilitation

Activity and Interaction: Rehabilitation and Demolition of Infrastructure			
Impact Description: Demolition and the removal of infrastructure may result in fugitive dust emissions and nuisance effect.			
Prior to mitigation/ management			
Dimension	**Rating**	**Motivation**	**Significance**
Duration	Short term (2)	Impacts will be short-term	(18) Negligible (negative)
Extent	Limited (2)	Emissions will be limited to site and immediate surroundings	
Intensity	Minor (2)	Minor, no significant change to baseline	
Probability	Probable (3)	Probable impacts will occur	
Nature	Negative		
Mitigation/ Management actions			
▪ Apply wetting agents, dust suppressant or binders on the exposed areas (including excavated material and roads); ▪ Enforce vehicle speed limits on site; ▪ Always keep the area of disturbance to a minimum; ▪ Minimise the drop heights when loading and unloading material onto trucks; ▪ Dismantling of infrastructure should be done in phases; and ▪ Vegetation of rehabilitated area and re-vegetation if necessary.			

Activity and Interaction: Rehabilitation and Demolition of Infrastructure			
Post- mitigation			
Dimension	**Rating**	**Motivation**	**Significance**
Duration	Short term (2)	Impacts will be short-term	(4) Negligible (negative)
Extent	Very Limited (1)	Impacts will be very limited to the Project site	
Intensity	Minimal (-1)	Minimal impacts anticipated	
Probability	Highly unlikely (1)	It is unlikely that impacts will occur after mitigation	
Nature	Negative		

11 Cumulative Impacts

Cumulative impacts result from the aggregation and interaction of impacts on a receptor and may be the product of past, present or future activities. (Franks et al, 2010). Seven operational coal mines are within a radius of 12 km from the proposed Project (Figure 8-1), that are having impacts on the ambient air quality and will continue to do in the foreseeable future.

PM_{10} and $PM_{2.5}$ emissions from the modelled future sources associated with the Project were added to existing monitoring data to derive a "*future baseline*" for cumulative assessment. The maximum background concentration was added to the GLC predicted at the exposed receptors, in this case Belfast and Siyathuthuka to obtain the "total impact" for each averaging period.

Since background measurements were taken near Belfast, the modelled GLC at this location was added to the 90th percentile (the value for 90% of the data are smaller) to ascertain future baseline (Table 11-1). In this case, the 90th percentile was 9.4 µg/m^3 (rounded up to 10 µg/m^3) for PM_{10} daily and 6.8 µg/m^3 (rounded up to 7 µg/m^3) for $PM_{2.5}$ daily.

The estimated "future baseline" values for PM_{10} and $PM_{2.5}$ (modelled + background) at Belfast are below the current regulatory limits.

Table 11-1: Cumulation Assessment "Future Baseline"

Pollutants	**Averaging Period**	**South Africa Air Quality Standard (µg/m^3)**	**Modelled Concentration (µg/m3)**	**Measured Background Concentration at Belfast (µg/m3)**	**Modelled + Background for Belfast (µg/m3)**
			Belfast		
PM_{10}	Daily	75(1)	48	10	**58**
$PM_{2.5}$	Daily	40(1)	9.6	7	**17**

12 Environmental Management Plan

12.1 Most Significant Air Quality Impacts

This section lists the main aspects that are expected to have more impact on ambient air quality due to the Project phases (Table 12-1), based on model simulations.

Table 12-1: Most Significant Impacts

Operational Phase	
Aspects	**Potential Significant Impacts**
Emissions from dirt roads due to hauling of ore to the plant and off site to the local market	*Nuisance effect and possible health implications from exposure to airborne dust*
Wind erosion of stockpiles	*Nuisance effect and possible health implications from exposure to airborne dust*

12.2 Summary of Mitigation and Management

Table 12-2 provides a summary of the activity, environmental aspects and impacts on the receiving environment. Information on the mitigation, relevant legal requirements, recommended management plans, timing of implementation, and roles / responsibilities of persons implementing the Environmental, Management Plan (EMP) are highlighted.

Table 12-2: Proposed Mitigation and Management Measures

Activities	Potential Impacts	Aspects Affected	Phase	Mitigation	Standard to be Achieved/Objective
▪ Site clearing; ▪ Access and haul road construction; ▪ Construction of Infrastructure; ▪ Topsoil stockpiling; and ▪ Loading, transport, tipping and spreading of materials	Reduction in the quality of ambient air due to generation of dust	Air Quality	Construction	▪ Apply wetting agents, dust suppressants and binders on exposed areas; ▪ Limit activity to non-windy days (with wind speed ≥ 5.4 m/s); ▪ Keep the area of disturbance to a minimum and avoid any unnecessary clearing, digging or scraping, especially on windy days; ▪ Construct surfaces of all access roads from lateritic soils and avoid fine/colloidal (e.g. clays and silts) materials; ▪ Minimise the drop heights when loading onto trucks and at tipping points; and ▪ Set maximum speed limits and have these limits enforced.	▪ Mineral and Petroleum Resource Development Act (Act 28 of 2002); ▪ South African National Environmental Management: Air Quality Act, Act.39 of 2004 – Air Quality Standard: 2009, 2012. ▪ National Environmental Management: Air Quality Act (Act.39 of 2004) – Dust Control Regulation, 2013.
▪ Open pit establishment; ▪ Removal of rock; ▪ Stockpiling; ▪ Operating processing plant; ▪ Storage, handling and treatment of hazardous products; ▪ Material handling processes; ▪ Hauling of ore and discard waste; ▪ Crushing and screening; ▪ Wind erosion from storage piles and exposed areas; and ▪ Generator sets.	Reduction in the quality of ambient air due to the generation of dust	Air Quality	Operation	▪ Apply wetting agents, dust suppressants and binders on exposed areas; ▪ Limit activity to non-windy days (with wind speed ≥ 5.4 m/s); ▪ always Minimise the area of disturbance and avoid any unnecessary clearing, digging or scraping, especially on windy days; ▪ Minimise drop heights when loading onto trucks and at conveyor tipping points; ▪ Monitor dust deposition rates and PM10 to ensure compliance with regulations; ▪ Use of low sulfur fuel; ▪ Operate the generators at optimal conditions generators should be operated at optimal condition; ▪ Vegetate exposed areas as soon as practicably possible; ▪ Enclose the crusher, screens, transfer and discharge points and conveyors; and ▪ Set maximum speed limits and have these limits enforced.	▪ South African National Environmental Management: Air Quality Act, Act.39 of 2004 – Air Quality Standard: 2009, 2012. ▪ National Environmental Management: Air Quality Act (Act.39 of 2004) – Dust Control Regulation, 2013. ▪ National Environmental Management: Air Quality Act (Act.39 of 2004) – Listed Activities and Associated Minimum Emission Standard, 2013. ▪ National Atmospheric Emissions Reporting Regulation, 2015

Activities	Potential Impacts	Aspects Affected	Phase	Mitigation	Standard to be Achieved/Objective
▪ Demolition and removal of infrastructure ▪ Rehabilitation of project area	Reduction in the quality of ambient air due to generation of dust	Air Quality	Decommissioning	▪ Dismantling of infrastructure should be done in phases; ▪ Minimise drop heights when loading and offloading; ▪ Limit demolition activities to non-windy days (≥5.4 m/s); ▪ Apply wetting agents, dust suppressant and binders on dirt roads and exposed areas; and ▪ Rehabilitated landscape should be vegetated and monitored for vegetation establishment in line with the Rehabilitation and Closure Plan.	▪ South African National Environmental Management: Air Quality Act, Act.39 of 2004 – Air Quality Standard: 2009, 2012. ▪ National Environmental Management: Air Quality Act (Act.39 of 2004) – Dust Control Regulation, 2013 ▪ National Environmental Management: Air Quality Act (Act.39 of 2004) – Listed Activities and Associated Minimum Emission Standard, 2013 ▪ National Atmospheric Emissions Reporting Regulation, 2015

13 Recommendations

The following recommendations based on the results presented in this report will be applied to this Project to ensure compliance with the regulatory standards:

- Administer mitigation measures in line with current engineering best practice, as described in the impact assessment above; and
- Commission an ambient air quality monitoring network and data from the network will be used to assess the efficiency of the mitigation measure in place at the mine. The monitoring station must be maintained for the LOM.

13.1 Monitoring Programme

This section presents the requirements, methodology, frequency and locations for the monitoring of air quality (Table 13-1). This will cover aspects that have to do be the baseline, impact monitoring during the construction and operational phases and data will be used to assess compliance.

Table 13-1: Monitoring Programme (Pre-construction and LOM)

Method	Proposed Monitoring Location	Frequency	Target	Reporting
Monitoring in accordance with the ASTM 1739-98 (R2017)	Five dust monitoring locations have been recommended. The coordinates are indicated below: MBU_01: 202489 E; 7150190 S; MBU_02: 800888 E; 7147441 S MBU_03: 201331 E; 7146754 S MBU_04: 202981 E; 7144248 S MBU_05: 203123 E; 7147444 S	Monthly dust deposition measurements;	▪ South African National Environmental Management: Air Quality Act, Act.39 of 2004 – Air Quality Standard: 2009, 2012. ▪ National Environmental Management: Air Quality Act (Act.39 of 2004) – Dust Control Regulation, 2013. ▪ National Atmospheric Emissions Reporting Regulation, 2015	A designated air quality officer to collect data/analyse and reporting to regulatory authorities on compliance.
PM_{10} and $PM_{2.5}$ (EN12341; EN14907)	Fine particulate sampling point: PM: 202106 E; 7147082 S	Continuous PM_{10} monitoring		
SO_2, NO_2 and CO	G_01: 202489 E; 7150190 S; G_02: 800888 E; 7147441 S G_03: 201331 E; 7146754 S G_04: 202981 E; 7144248 S G_05: 203123 E; 7147444 S	Bi-annual		

14 Conclusion

This study was undertaken to understand the air quality impacts associated with the proposed Project. Pollutants quantified and evaluated in this assessment included TSP, PM_{10} and $PM_{2.5}$.

The modelling results (isopleths of GLC) presented in this report confirmed that impacts will occur outside the Project boundary. The exposure levels predicted at the nearby receptors Siyathuthuka and Belfast were below the South African standards.

Although the findings from this study indicates major (negative) impacts during the operational, this represented the worst-case scenario (without mitigation measures in place). With mitigation measure applied, as shown with the dust deposition rates, exceedances of the limit values were confined to the Project boundary.

Based on the isopleths of GLC predicted, management must ensure intervention measures to mitigate and further reduce emissions at source are part of the day-to-day practices on commencement of mining operation.

Despite the aforementioned, the air quality specialist does not object to the Project from an air quality perspective as envisaged impacts will be insignificant after mitigation measures are applied.

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Appendix A: Specialist CV

Dr Matthew Ojelede

Division: Ecology and Atmospheric Science

Manager: Atmospheric Science and Noise

Digby Wells Environmental

16 Education

BSc (Hons) Geology (University of Benin, Edo State, Nigeria)

MSc Environmental Science (WITS) with course work:

- Environmental Chemistry
- Environmental Management
- Air Quality –Physics and Chemistry of the Urban Atmosphere
- Global Environmental Change: Adaptation and Mitigation
- Geographic Information System
- Mining and the Environment

PhD Environmental Management (UJ)

17 Language Skills

English and Edo language

18 Employment

June 2012 – September 2012	University of Johannesburg (Researcher)
October 2012 to present	Digby Wells Environmental

19 EXPERIENCE

I have spent much of my time as a research assistant in the field of “Atmospheric Sciences” with active involvement in teaching and training students under the tutelage of leading scientific researchers (e.g. Prof Annegarn) during my time as an MSc Environmental Science student/research assistant at the University of the Witwatersrand (Wits) and PhD Environmental Management student/research assistant at the University of Johannesburg (UJ).

During my time at Wits – knowledge was acquired from courses such as “Physics and Chemistry of Urban Atmosphere”, “Mining and the Environment” and “Global Environmental Change – Mitigation and Adaptation”, as well as my research on “NOx production from lightning over Southern Africa”. These skills were applied while working as a research intern with the company *Annegarn Environmental Research* (AER) Pty Ltd. In this position, I was tasked with setting up, monitoring and decommissioning ambient air quality units and stations. Much of the work revolved around the measurement of airborne particulate matter (PM_{10}) and the dust deposition rates in the vicinity of coal and gold mines in the Witwatersrand - Gauteng, Free State, North West and Mpumalanga Provinces respectively.

While at the University of Johannesburg, I was tasked with the responsibility of conducting several "stand alone" air quality assessments for mining companies under the tutelage of Prof. Harold Annegarn – a renowned air quality expert. My responsibilities encompass data collection (bulk and airborne samples) at source and at sensitive receptors, laboratory analysis at Spectrum (The Central Analytical Facility of the Faculty of Science at the University of Johannesburg). Analyses conducted includes: XRF–ray Fluorescence (XRF), X-ray Power Diffraction (XRD), and microscopic examination of filter samples. I am conversant with the Malvern Particle Analyser® - an instrument used to size particulate material into 32 size bins (0.25 µm to 32 µm).

Further work experience was gained while conducting analyses at iThemba Laboratory in Cape Town where my understanding of the analytical technique for phase identification of crystalline material was enhanced. In line with the aforementioned, additional studies have been conducted on the "Wind erosion of tailings in the Witwatersrand and the potential air quality implications for exposed residents". These studies contributed to the existing literature and helped in understanding the ground level concentrations and exposure scenarios to quartz, elemental species and radioactivity associated with airborne dust. With years of experience in monitoring, analyses and interpretation of data and relevant legislations, the opportunity was provided to assist in a variety of air quality projects for several mining companies - Crown Gold Recoveries, Eastplat, Anglogold Ashanti.

After the award of my doctoral degree, the University of Johannesburg (UJ) offered me a position as a researcher (where I spent two months before joining Digby Wells Environmental). At UJ, one of the responsibilities I was tasked with was to assist in a regional air quality study with a group of scientists from Wits, University of Pretoria and the National Health Laboratory Service (NHLS) in looking at the "Adverse Health Impacts Associated with Dust Emissions from Gold Mine Tailings on the Witwatersrand" for the Mine Health and Safety Council.

On the 1st October 2012, I joined Digby Wells Environmental as an Air Quality Specialist, where I am currently still employed. The following responsibilities fall under my portfolio:

- Design ambient data collection methodology and assessment;
- Set up particulate and gaseous monitoring equipment;
- Data analysis and interpretation in order to assess compliance and contribute to the assessment of the background air quality and predict future perturbation arising from a proposed project and validation of the measurements through dedicated quality assurance checks;
- Atmospheric Emissions Licencing applications;
- Perform dispersion modelling of pollutants arising from different sources and activities using a regional transport model (AERMOD and CALPUFF);
- Compiling Ambient Air Quality Impact Assessment reports, amongst others.
- Atmospheric Emissions Licencing applications;

- Perform dispersion modelling of pollutants arising from different sources and activities using a regional transport model (AERMOD and CALPUFF); and
- Compiling Ambient Air Quality Impact Assessment reports.

My role at Digby Wells Environmental has broadened since 2013 when I was promoted to the position of Manager, Atmospheric Sciences. Additional duties include:

- Overseeing affairs within the unit, including mentoring of juniors and interns;
- Coordinating the installation of meteorological stations at locations in South African and other African countries i.e. South Africa (Dalyshope Project – Anglogold Ashanti); Malawi (Mkango Project) and Liberia (Putu Project);
- Coordinating stack emission testing;
- Design sampling methodology and coordinating the installation of passive gas samplers;
- Weekly participation at project meeting, to assess budget, deadlines and working to ensure the client deliverables are finalised on-time and within budget;
- Monthly reporting to and attending of the Management Committee of the company;
- Contribute to national/international conferences and seminars on "Atmospheric Pollution" by way of participation, presentation of research results and scientific publications.

19.1 Abridged Project Experience at Digby Wells Environmental:

- Air Quality Impact Assessment study and model for an IPP power station and associated infrastructure, Limpopo, South Africa;
- Ventersburg Gold Mine Air Quality Impact Assessment study and model, Free State, South Africa;
- Air Quality Baseline Assessment study for Falea Uranium Project, Mali;
- Air Quality Scoping report for the Harwar Colliery Mpumalanga, South Africa;
- Baseline Air Quality Assessment study for Mkango Resources Limited, Songwe Rare Earth project, Malawi;
- Air Quality Impact Assessment study and model for the proposed Balama Graphite Mine, Mozambique;
- Air Quality Impact Assessment study and model for New Liberty Gold Mine, Liberia;
- Air Quality Impact Assessment study and model for Loulo Gold Mine, Mali;

My organizational abilities, innovation, timeliness, scientific spirit, and proven skills in writing scientific articles and reports have been brought to bear in a number of local and international air quality studies conducted for clients over the past years.

20 Professional affiliations

National Association for Clean Air (**NACA**)

South African Society for Atmospheric Sciences (**SASAS**)

South African Council for Natural Scientific Professions (**SACNASP**)

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