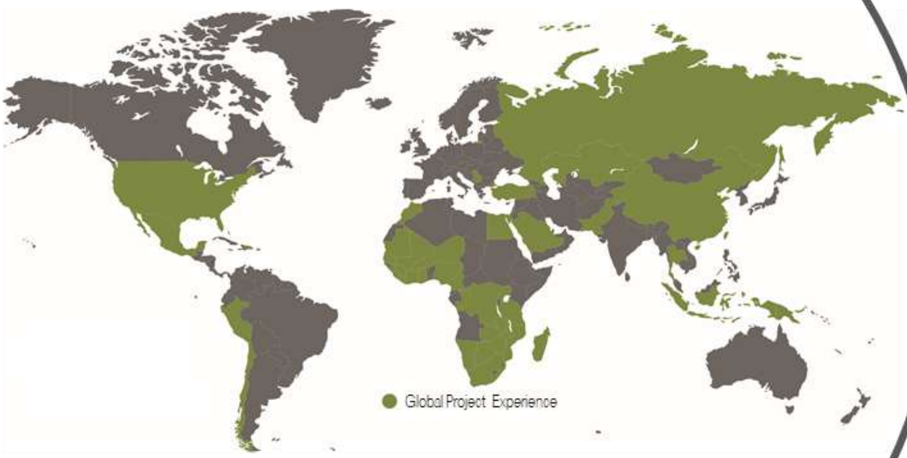

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Universal Coal Dalyshope Mining Project in the Magisterial District of Lephalale, Limpopo Province

Air Quality Impact Assessment

Prepared for:
Universal Coal Plc

Project Number:
UCD6170

September 2020

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Company Registration: 2010/008577/07

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This document has been prepared by Digby Wells Environmental.

Report Type:	Air Quality Impact Assessment
Project Name:	Universal Coal Dalyshope Mining Project in the Magisterial District of Lephalale, Limpopo Province.
Project Code:	UCD6170

Name	**Responsibility**	**Signature**	**Date**
Matthew Ojelede Pr.Sci.Nat.	Report Compiler		September 2020
Barbara Wessels	Reviewer		September 2020

DETAILS AND DECLARATION OF THE SPECIALIST

Digby Wells and Associates (South Africa) (Pty) Ltd.

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Brief Background of Specialist

Matthew has broad knowledge in the “*Atmospheric Sciences*” field, with more than 15 years of experience in academia and industry combined. He has garnered practical field experiences in setting up, monitoring, and decommissioning ambient air quality units and stations, encompassing real-time particulate monitor – AQ-Mesh®, Grimm Aerosol monitor®, Met-One E-Sampler®, radiello® passive/diffusive samplers for environmental monitoring, indoor and outdoor air monitoring, industrial air quality (IAQ), personal sampling and breathing zone assessment.

He is currently registered as a Professional Natural Scientist with the South African Council for Natural Scientific Professions (Reg. No. 116980/18) and is a member of the National Association for Clean Air. He has authored and co-authored research articles and conference papers in peer-reviewed journals both locally and internationally.

Full name:	Matthew Ojelede
Title/Position:	Air Quality Specialist
Qualification(s):	BSc (Hon); MSc; PhD
Experience (years):	15 Years
Registration(s):	National Association for Clean Air (NACA) International Association for Impact Assessment South Africa (IAIAsa) South African Council for Natural Scientific Professions (SACNASP)

I, Matthew Ojelede, declare that: –

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

September 2020

Signature of the Specialist *Date*

Findings, recommendations and conclusions provided in this report are based on the best available scientific methods and the author's professional knowledge and information at the time of compilation. Digby Wells employees involved in the compilation of this report, however, accepts no liability for any actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, and by the use of the information contained in this document.

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Any recommendations, statements or conclusions drawn from or based on this report must clearly cite or make reference to this report. Whenever such recommendations, statements or conclusions form part of a main report relating to the current investigation, this report must be included in its entirety.

EXECUTIVE SUMMARY

The Dalyshope Project is a Joint Venture (JV) between Anglo American Corporation (AAC) and Universal Coal plc (Universal). AAC is the holder of a Prospecting Right, to extract coal. The Remaining Extent of the Farm Dalyshope 232 LQ and the Remaining Extent of the Farm Klaarwater 231 LQ are the directly affected farm portions. The Project is in the Limpopo Province of South Africa, some 54 km to the west of Lephalale, 39 km northwest of the Matimba and Medupi power stations, close to the Botswana border that is demarcated by the Limpopo River.

A suite of specialist studies was conducted in support of the Mining Right and Environmental Authorisation Applications, which considers the establishment of a contractor-operated, truck and shovel opencast mine. An Air Quality Impact Assessment (AQIA) forms part of the suite of specialist studies. According to the revised and updated Mine Works Programme (MWP – 1921/006730/07), the average strip ratio for over the initial 30-year mining period is 0.31:1 Bank Cubic Meters (BCM) per Run of Mine tonne (ROMt). The applicant intends to develop a coal mine in the Waterberg area on the farms Klaarwater 231 LQ and Dalyshope 232 LQ. The quantity of coal to be extracted from the proposed pit is approximately 2.4 million tonnes per annum (Mtpa) of thermal coal product for approximately five years. After five years, the mine will ramp up production to approximately 12 Mtpa of product for approximately 25 years from a single open pit (OC1), giving a total LoM of approximately 30 years

The AQIA was set out to establish the current air quality scenario in the proposed MRA and evaluate the future perturbation from the proposed Project operational phase and associated cumulative impacts. This assessment was limited to Block OC 1 and associated activities in an opencast mining operation. For this study, the approach adopted was to assess the worst-case scenario (i.e. without mitigation measures in place), which may have resulted in the model over-estimating the predicted impacts.

Findings from the baseline assessment have confirmed that the meteorology is influenced by dominant winds from the northeast and east-northeast respectively. The average wind speed was observed to be ~3.1 m/s, with winds greater than 5.4 m/s occurring for 7.3% of the time (with data showing records of wind speeds that ranged between 7.0 m/s to 11.0 m/s). Therefore, an unplanned event of a sudden wind gust sweeping through the proposed MRA is possible.

For dustfall (particulate matter with an aerodynamic diameter less than 45 μm (considered as Total Suspended Particulate (TSP)), data from 12 months of monitoring at eight sites were used to evaluate the background scenario. Measured dustfall rates were below the residential and non-residential limits for most of the sites, except for those in the vicinity of a cattle feedlot. The results show that the 90th percentiles of the dustfall data measured were below 588 mg/m^2/d. For the fine particulate matter, data from a quality continuous monitor (AQ-Mesh) was used to confirm the current status quo. The highest ambient concentration of particulate matter with an aerodynamic diameter of less than 10 microns and 2.5 microns i.e. PM_{10} and $PM_{2.5}$ measured were below 5 μg/m^3. These maximums for PM_{10} and $PM_{2.5}$ were at

6% and 8% of the respective regulatory limits. For the gaseous pollutants, the highest values measured for sulfur dioxide (SO_2), nitrogen dioxide (NO_2), and carbon dioxide (CO) were at 4%, 38%, and 1% of their respective regulatory limit values.

Predicted emissions anticipated from the operational phase of the Project was assessed using a conceptual model. Model simulations of Ground Level Concentration (GLC) of criteria pollutants were generated using the American Meteorological Society and the United States Environmental Protection Agency (USEPA) Regulatory Model (AERMOD). Isopleths were generated for different averaging periods as recommended by the regulatory authorities and compared with the South African standards to ascertain compliance.

A summary of the predicted GLC is given below:

- The predicted 24-hr $PM_{2.5}$ GLC shows that there will be exceedances of the South African standard of 40 µg/m. These exceedances will be largely confined to the MRA. The GLC predicted for the nearby sensitive receptor locations SR 1 and SR 2 were below the daily limit. The predicted annual GLC of $PM_{2.5}$ were below the South African standard of 20 µg/m³. With mitigation measures in place, the area with exceedance within the MRA can be reduced, while ensuring compliance with the standard at the boundary.
- The predicted 24-hr GLC of PM_{10} confirmed that exceedances of the South African standard of 75 µg/m³ will occur. Although the area with exceedances will be mostly confined to within the MRA, adjacent areas some 1 km east, north, and west outside the MRA will be affected. The annual PM_{10} GLC showed that the predicted exceedances will be confined within the MRA. As a result, the GLC at the nearby sensitive receptors were below the South African standard of 40 µg/m³.
- The predicted dustfall rates show that exceedances of the non-residential limit of 1,200 mg/m^2/d will occur within the MRA and adjacent areas in the southwest direction (downwind). The predicted dustfall rates at the selected sensitive receptors were below the residential limit of 600 mg/m^2/d and non-residential limit.
- The predicted NO_2 1-hr GLC shows that exceedance of the South African standard of 200 µg/m^3 will be experienced within the MRA and areas adjacent to the southwestern boundary. The predicted levels will be lower than what is predicted now if mitigation measures are implemented. The GLCs at the nearby receptors were lower than the standard.
- The predicted SO_2 24-hr GLC shows that exceedance of the South African standard of 125 µg/m^3 is not likely to occur during the operational phase. The isopleth shows that the area with elevated emissions will be confined within the MRA, with negligible implications on surrounding sensitive receptors.

The cumulative impacts assessed by a combination of the model prediction and the background levels confirmed that the final concentrations will be within regulatory limit values at some receptor locations.

The impacts of the proposed Project were evaluated using a risk matrix that considers the nature, significance, extent, duration, and probability of impacts occurring. Based on this rating system, impacts on the surrounding receptors from the operational phase are deemed "major negative" without mitigation. However, with mitigation, the impacts were reduced to "negligible negative". Since anticipated emissions from the operational phase activities are likely to influence receptors outside the MRA boundary, mitigation and management interventions are crucial.

Some of the possible mitigation measures and management interventions recommended include:

- Application of dust suppressants/binders on haul roads and exposed areas, setting maximum speed limits on haul roads and to have these limits enforced, rehabilitation of stockpiles to prevent wind erosion (considering that haul roads and wind erosion from storage facilities are amongst the highest emissions sources), and enclosure of crushers;
- Operation of ambient air quality monitoring network for particulates and gases to provide valuable data needed to assess the effectiveness of mitigation measures in place; and
- Relocation of receptor location within a 2.0 km radius.

Once the mine implements the recommended mitigation measures outlined in this report, associated emissions can be contained to below standards, ensuring compliance with regulatory requirements.

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ACRONYMS, ABBREVIATIONS AND DEFINITION

ACC	Anglo American Corporation
AERMOD	American Meteorological Society/United States Environmental Protection Agency Regulatory Model
AQIA	Air Quality Impact Assessment
CIH	Community Investment Holdings
CO	Carbon Monoxide
DEA	Department of Environmental Affairs
EMPr	Environmental Management Plan Report
ESIA	Environmental and Social Impact Assessment
GLC	Ground Level Concentrations
LDEDET	Limpopo Department of Economic Development, Environment, and Tourism
LOM	Life of Mine
MM5	Mesoscale model - Fifth generation
MRA	Mining Right Area
Mtpa	Million tonnes per annum
NDCR	National Dust Control Regulations (GN R827 of 2013)
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
NEMAQA	National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004)
NO_2	Nitrogen Dioxide
PM_{10}	Particulate Matter less than 10 microns in diameter
$PM_{2.5}$	Particulate Matter with Aerodynamic Diameter less than 2.5 Micron
ROM	Run of Mine
SAAELIP	South African Atmospheric Emission Licensing & Inventory Portal
SO_2	Sulfur Dioxide
tpa	Tonnes per annum
TSP	Total Suspended Particulates
USEPA	The United States Environmental Protection Agency
WBG	World Bank Group
WBPA	Waterberg–Bojanala Priority Area
WHO	World Health Organisation

CONTENT OF THIS REPORT IN ACCORDANCE WITH THE REGULATION GNR982 OF 2014, APPENDIX 6 (AS AMENDED)

Legal Requirement		Section in Report
(1)	A specialist report prepared in terms of these Regulations must contain-	
(a)	details of- (i) the specialist who prepared the report; and (ii) the expertise of that specialist to compile a specialist report including a curriculum vitae;	Page iii and iv Section 2
(b)	a declaration that the specialist is independent in a form as may be specified by the competent authority;	Page iii and iv
(c)	an indication of the scope of, and the purpose for which, the report was prepared;	Section1 and Section 1.2
cA	And indication of the quality and age of the base data used for the specialist report;	Section 5
cB	A description of existing impacts on site, cumulative impacts of the proposed development and levels of acceptable change;	Section 6
(d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 5
(e)	a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of the equipment and modelling used;	Section 5
(f)	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 alternatives;	Section 6
(g)	an identification of any areas to be avoided, including buffers;	N/A
(h)	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 6
(i)	a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 3

<table>
<tr><th colspan="2">Legal Requirement</th><th>Section in Report</th></tr>
<tr><td>(j)</td><td>a description of the findings and potential implications of such findings on the impact of the proposed activity or activities;</td><td>Section 6
Section 7</td></tr>
<tr><td>(k)</td><td>any mitigation measures for inclusion in the EMPr;</td><td>Section 9</td></tr>
<tr><td>(l)</td><td>any conditions/aspects for inclusion in the environmental authorisation;</td><td>Section 13</td></tr>
<tr><td>(m)</td><td>any monitoring requirements for inclusion in the EMPr or environmental authorisation;</td><td>Section 10</td></tr>
<tr><td rowspan="3">(n)</td><td>a reasoned opinion (Environmental Impact Statement) -</td><td>Section 13</td></tr>
<tr><td>whether the proposed activity, activities or portions thereof should be authorised; and</td><td>Section 13</td></tr>
<tr><td>if the opinion is that the proposed activity, activities 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;</td><td>Section 9</td></tr>
<tr><td>(o)</td><td>a description of any consultation process that was undertaken during the course of preparing the specialist report;</td><td>Section 11</td></tr>
<tr><td>(p)</td><td>a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and</td><td>Section 11</td></tr>
<tr><td>(q)</td><td>any other information requested by the competent authority.</td><td>N/A</td></tr>
</table>

1. Introduction

The Dalyshope Project is a Joint Venture (JV) between Anglo American Corporation (AAC) and Universal Coal plc (Universal). AAC is the holder of a Prospecting Right to extract coal. The Remaining Extent of the Farm Dalyshope 232 LQ and the Remaining Extent of the Farm Klaarwater 231 LQ are the directly affected farm portions.

The Project is in the Limpopo Province of South Africa, some 54 km to the west of Lephalale, 39 km northwest of the Matimba and Medupi power stations, close to the Botswana border that is demarcated by the Limpopo River. The Stockpoort border post between South Africa and Botswana is ~ 17.5 km from the Dalyshope resource area.

The nearest sizeable town is Lephalale, and the nearest accessible railway siding is at Boikarabelo, which is ~ 15 km southwest of Dalyshope. Community Investment Holdings (CIH)/Resource Generation Ltd (Resgen) plans to construct a rail line link, with a loadout loop, from the existing rail line, near Lephalale, up to a position ~ 15 km from the Dalyshope Project. CIH shall be approached to negotiate to share this rail link. Alternatively, the coal shall be trucked to the existing rail line at Grootegeluk Mine. This line links into the general rail network at Lephalale that allows coal to be hauled to Maputo or Richards Bay or Matimba/Medupi.

1.1. Project Background and Description

This Mining Right Application considers the establishment of a contractor-operated, truck and shovel opencast mine. According to the revised and updated Mine Works Programme (MWP – 1921/006730/07), the average strip ratio for the initial 30-year mining period is 0.31:1 Bank Cubic Meters (BCM) per Run of Mine tonne (ROMt). The mining strips in Block OC1 start at ~ 2,100 m and extend to 3,000 m for most of the life of Block OC1.

The applicant intends to develop a coal mine in the Waterberg area on the farms Klaarwater 231 LQ and Dalyshope 232 LQ. The quantity of coal to be extracted from the proposed pit is approximately 2.4 million tonnes per annum (Mtpa) of thermal coal product for approximately five years. After five years, the mine will ramp up production to approximately 12 Mtpa of product for approximately 25 years from a single open pit (OC1), giving a total Life of Mine (LoM) of approximately 30 years

Opencast strip mining using selective mining techniques was the preferred mining method for this deposit. This method suits coal seams that are situated relatively close to the surface and in a consistent, flat-lying orientation.

The mine is accessed by a box-cut and ramp arrangement located in the north-east corner of the farm Dalyshope. Overburden material is hauled to spoil until sufficient void has been created within the pit to allow for in-pit tipping. Selective mining of the coal seams is not required due to the specification of the product required but selective mining of the partings will be conducted.

The ROM coal will be transported to a stockpile at the top of the pit. The ROM coal will be fed into a pit-head primary crusher from where it will be transported by conveyor belt to the ROM stockpiles before going to the washing plant.

ROM coal from the pit will be crushed in a primary crusher at the pit head. The crushed coal will be transported by conveyor belt from the pit head to the stockpiles before going to the washing plant. Coal will be removed from the stockpile and fed into the plant. The coal will be screened to remove -50mm coal. The oversize coal will be crushed in a secondary crusher before re-joining the -50mm coal. The -50mm coal is fed into the cyclone plant whereby it will be washed at a density of 1.80 to produce the product and discard.

The washing plant will be in a modular format with two modules each capable of a throughput of 1000 tons per hour. The discard will be taken by conveyor belt back to the pithead where it will be loaded into trucks to be deposited back into the bottom of the pit.

The product will be placed on stockpiles before being transported to the market. The product will either be transported by road haulers on the district/provincial road or using rail should a rail line prove economically viable.

1.2. Scope of Work

Based on the requirements of the Project, the air quality scope of work encompasses the following:

- Establishment of the site meteorology and ambient air quality baseline;
- Assessment of the future air quality impacts and comparison against regulatory standards for compliance; and
- Recommendation of management measures, including mitigation and monitoring requirements.

2. 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 a BSc in Geology (Hons), an MSc in Environmental Science, and a Ph.D. in Environmental Management. He is a member of the South African Council for Natural Scientific Professions (SACNASP), and the National Association for Clean Air (NACA). Matthew has authored and co-authored research articles and conference papers in both local and international peer-reviewed journals.

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

3. Assumptions, Limitations and Exclusions

Assumptions, limitations, and exclusions pertaining to this Project are discussed in Table 3-1

Table 3-1:Assumptions, Limitations and Exclusions

Assumption, Limitation, or Exclusion	Consequence
This assessment excludes the other three pits (OC2, OC3 and OC4) and only considered pit "OC1"	No implication for the project because ore form Block OC1 will cater to the LOM coal resource However, the other pits will be considered when the LOM get extended.
The uncertainty associated with dispersion models	Since mining activities were selected to demonstrate the worst-case scenario, the predicted model GLC may have resulted in an overestimation

3.1. Proposed Infrastructure and Activities

The Project list of activities for the construction, operation, and decommissioning phases are depicted in Table 3-1 below.

Table 3-2: Proposed Project Activities

Project Phase	Project Activity
Construction Phase	Site/vegetation clearance
	Contractors laydown yard
	Access and haul road construction
	Infrastructure construction
	Diesel storage and explosives magazine
	Topsoil stockpiling
Operational Phase	Open-pit establishment
	Removal of rock (blasting)
	Stockpiling (rock dumps, soils, ROM, discard dump) establishment and operation
	Diesel storage and explosives magazine
	Operation of the open pit workings
	Operating crush and screen and coal washing plant
	Operating sewage treatment plant

Project Phase	Project Activity
	Water use and storage on-site – during the operation water will be required for various domestic and industrial uses. Water Management infrastructure including Two Pollution Control Dams (PCDs) will be constructed that capture water from the mining area, which will be stored and used accordingly. Workshop and storage of chemicals; Laundry and Laboratory services; Backfilling and concurrent rehabilitation; Weighing of coal trucks; Coal transportation through trucking, rail and conveyer belts; Washing of mine vehicles; and Fuelling of diesel on site.
	Storage, handling and treatment of hazardous products (including fuel, explosives and oil) and waste
	Maintenance activities – through the operations maintenance will need to be undertaken to ensure that all infrastructure is operating optimally and does not pose a threat to human or environmental health. Maintenance will include haul roads, processing plant, machinery, water and stormwater management infrastructure, stockpile areas, dumps, etc
Decommissioning Phase	Demolition and removal of infrastructure – once mining activities have been concluded infrastructure will be demolished in preparation for the final land rehabilitation.
	Rehabilitation – rehabilitation mainly consists of spreading of the preserved subsoil and topsoil, profiling of the land and re-vegetation
	Post-closure monitoring and rehabilitation

4. Relevant Legislation, Standards, and Guidelines

The legislation, regulation, and guidelines considered in this air quality report are tabulated and discussed briefly in Table 4-1. The applicable standards in terms of compliance are discussed in Section 4.1 below.

Table 4-1: Applicable Legislation, Regulations, Guidelines, and By-Laws

Legislation, Regulation, Guideline or By-Law	Applicability
National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) as Amended	Principles from NEMA are relevant to air pollution, Section 24(4) b(i) … "the investigation and assessment of the potential impacts of activities that

Legislation, Regulation, Guideline or By-Law	Applicability
The NEMA is the statutory framework to enforce Section 24 of the Constitution of the Republic of South Africa …(Section 24: ***the right to a healthy environment and the right to have the environment protected).*** The NEMA is intended to promote co-operative governance and ensure that the rights of people are upheld, but also recognising the necessity of economic development.	require authorisation or permission.", and Section 24(7).
National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) The prevailing legislation in the Republic of South Africa with regards to the Air Quality field is the National Environment Management: Air Quality Act, 2004 (Act No. 39 of 2004) (NEM: AQA). According to the Act, the DEA, the provincial environmental departments and local authorities (district and local municipalities) are separately and jointly responsible for the implementation and enforcement of various aspects of NEM: AQA. A fundamental aspect of the new approach to air quality regulation, as reflected in the NEM: AQA is the establishment of National Ambient Air Quality Standards (NAAQS). These standards provide the goals for air quality management plans and also provide the benchmark by which the effectiveness of these management plans is measured. The NEM: AQA provides for the identification of priority pollutants and the setting of ambient standards with respect to these pollutants.	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.
NEM:AQA National Dust Control Regulation 2013 (GN No. 827 of 2013) The Minister of Water and Environmental Affairs, released on 01 November 2013 the National Dust Control Regulation, in terms of Section 53, read with Section 32 of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004)(NEM:AQA). In the published National Dust Control Regulations, terms like target, action, and alert thresholds were omitted. Another notable observation was the reduction of the permissible frequency of exceedance from three to two incidences within a year. The standard adopted a more stringent approach than previously and would require dedicated mitigation plans now that it is in force.	The purpose of these Regulations is to prescribe general measures for the control of dust in all area.

4.1. Applicable South African Standard

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 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.

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).

NEM:AQA is the prevailing legislation in the Republic of South Africa with regards to Air Quality. NEM:AQA forms one of the many pieces of legislation 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 fines for contraventions. In line with NEM:AQA, the Department of Environmental Affairs (DEA) published National Dust Control Regulations (NDCR), the acceptable dustfall (particulate matter with an aerodynamic diameter less than 45 µm (considered as Total Suspended Particulate (TSP) as described by the World Bank Group (WBG) (WBG, 1998) limits for residential and non-residential areas (Government Notice R827 in Government Gazette 36975, November 1, 2013). The dust fallout standard is given in Table 4-2 below.

Table 4-2: Dust Fall Standards (NDCR, 2013)

Restriction Areas	Dustfall 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 particulate matter with an aerodynamic diameter less than 10 microns (PM_{10}) and gases in Table 4-3 since December

2009 and (particulate matter with an aerodynamic diameter less than 2.5 microns ($PM_{2.5}$) since June 2012 (GN 486: 2012) as in Table 4-4.

Table 4-3: 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 NO2 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 PM_{10} fraction of suspended particulate matter shall be EN 12341.				
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 the analysis of CO shall be ISO 4224.				

Table 4-4: 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 $PM_{2.5}$ fraction of suspended particulate matter shall be EN 14907.			

5. Methodology

5.1. Baseline Assessment

An evaluation of the baseline environment was conducted, coupled with a desktop study of the site-specific climate, with the potential to influence pollutant dispersion across the landscape. Also, baseline air quality was collected in the area and used to understand current air quality scenarios before the commencement of mining.

The Dalyshope Project is situated near Stockpoort and Steenbokpan, in the north-western part of the Waterberg District in the Limpopo Province, South Africa. The area has a fairly flat terrain, with elevation varying between 690 to 735 metres above mean sea level (mamsl). Agricultural activities are not as pronounced in the area, while game farming, residential, and mining are the observed land-use types. No human settlements are within the planned opencast mining area. The land is currently mainly used for game farming.

Figure 5-1 shows the MRA boundary. In Google Earth® Imagery, isolated homesteads are noticeably scattered around the landscape, and used as dust monitoring locations. These were considered as sensitive receptors, in accordance with the USEPA (2016). The latter described sensitive receptors amongst other things as "*an area where the occupants are more susceptible to pollutants*".

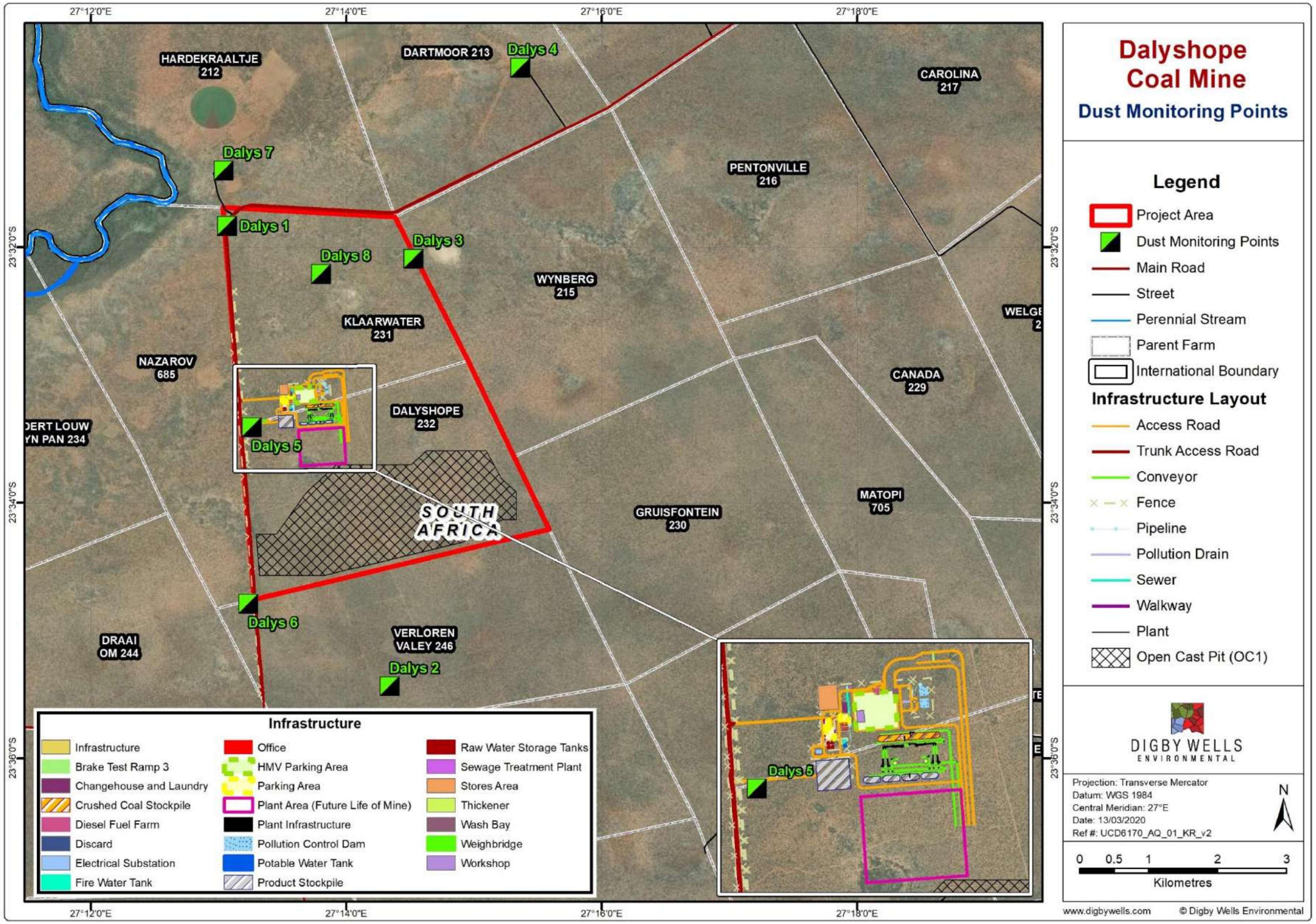


Figure 5-1: Project Boundary Showing Surrounding Receptors and Monitoring Sites

5.1.1. Desktop Assessment of Baseline Climate

Existing site-specific MM5 modelled meteorological data set for full three calendar years (2017 – 2019) obtained from the Lakes Environmental Software (hereafter Lakes) was used to assess the prevailing weather conditions. The Pennsylvania State University / National Centre for Atmospheric Research (PSU/NCAR) mesoscale model (known as MM5) is a limited-area, non-hydrostatic, terrain-following sigma-coordinate model, which was designed to simulate or predict mesoscale atmospheric circulation.

For this study, a wind rose to comprise 16 spokes, which represent the directions from which winds blew during the period was generated. The colours reflect the different categories of wind speeds. The dotted circles provide information regarding the frequency of occurrence. The figure given at the bottom of the legend described the frequency with which calm conditions (wind speed below 0.5 m/s) occur.

The meteorological data were used to assess the following parameters, such as temperature, relative humidity, wind speed, and direction for the MRA, which are discussed below.

5.1.1.1. Temperature

The monthly temperature for the MRA (3-year average) are presented in Table 5-1 and Figure 5-3. The data indicate that the monthly temperature average varied between 14°C and 26°C. Ambient temperatures were observed to be higher during the summer months.

5.1.1.2. Rainfall

The total monthly rainfall records (3-years average) are provided in Figure 5-2. Based on the rainfall data, the summer months (December – February) received most of the rain (i.e. >68%) with February being the peak rainfall month (Figure 5-2), followed by Spring with 18% and Autumn with 13%. While winter (June – August), received the least amount of rainfall.

5.1.1.3. Relative Humidity

The relative humidity per month (3-year average) ranged between 54% and 81% (Table 5-1 and Figure 5-3). Ravi *et al*., (2006)[1], investigated the effect of near-surface air humidity on soil erodibility. Results show that the *threshold friction velocity* decreases with values of relative humidity between about 40% and 65%. 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*.

[1] Ravi S; Zobeck TM; Over TM; Okin GS; 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 5-1: Climate Statistics

Parameters	3-year average												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Temp. (◦C)	25	26	25	24	21	18	14	14	16	20	22	25	21
Total Mon. Rain (mm)	65	124	37	3	8	0	1	0	8	20	46	91	404
Rel. Hum. (%)	70	70	70	71	74	79	81	75	65	59	56	54	69

(Source: Lakes Environmental)

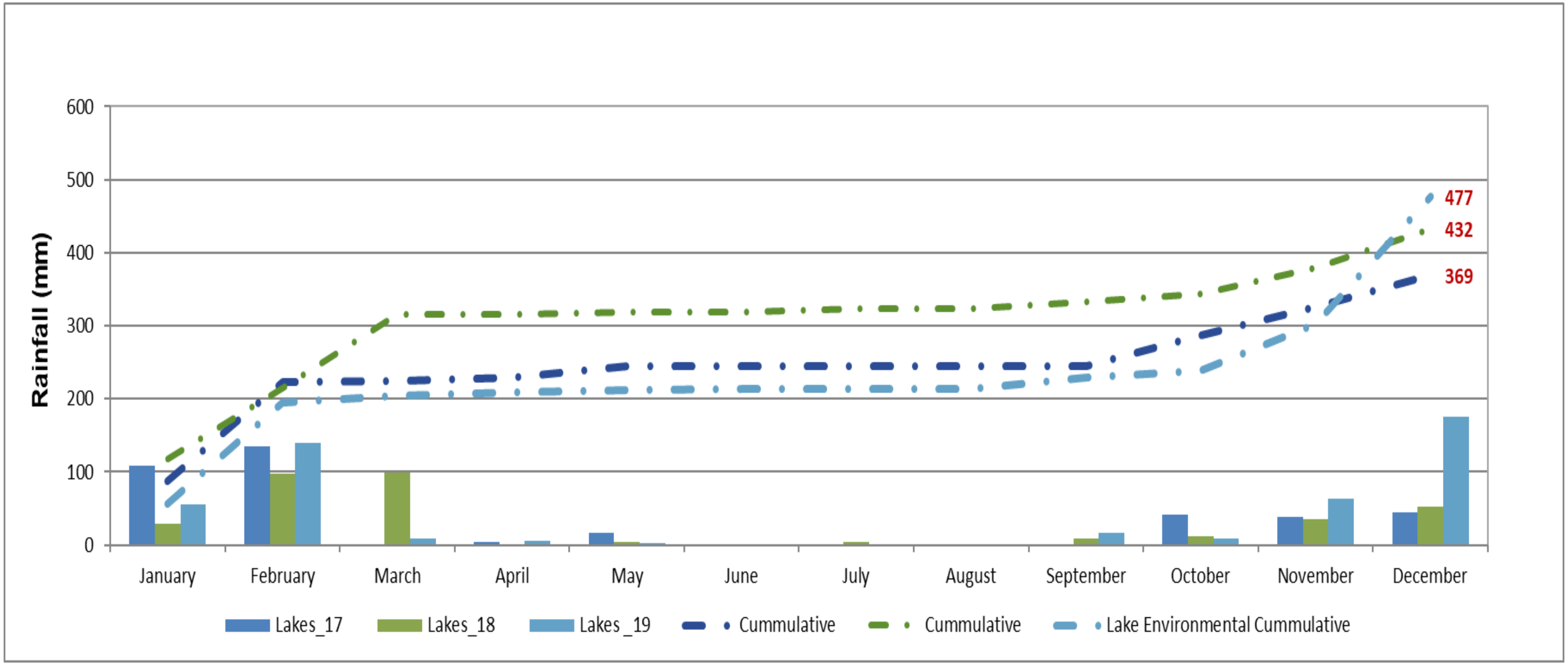


Figure 5-2: Rainfall

(Source: Lakes Environmental)

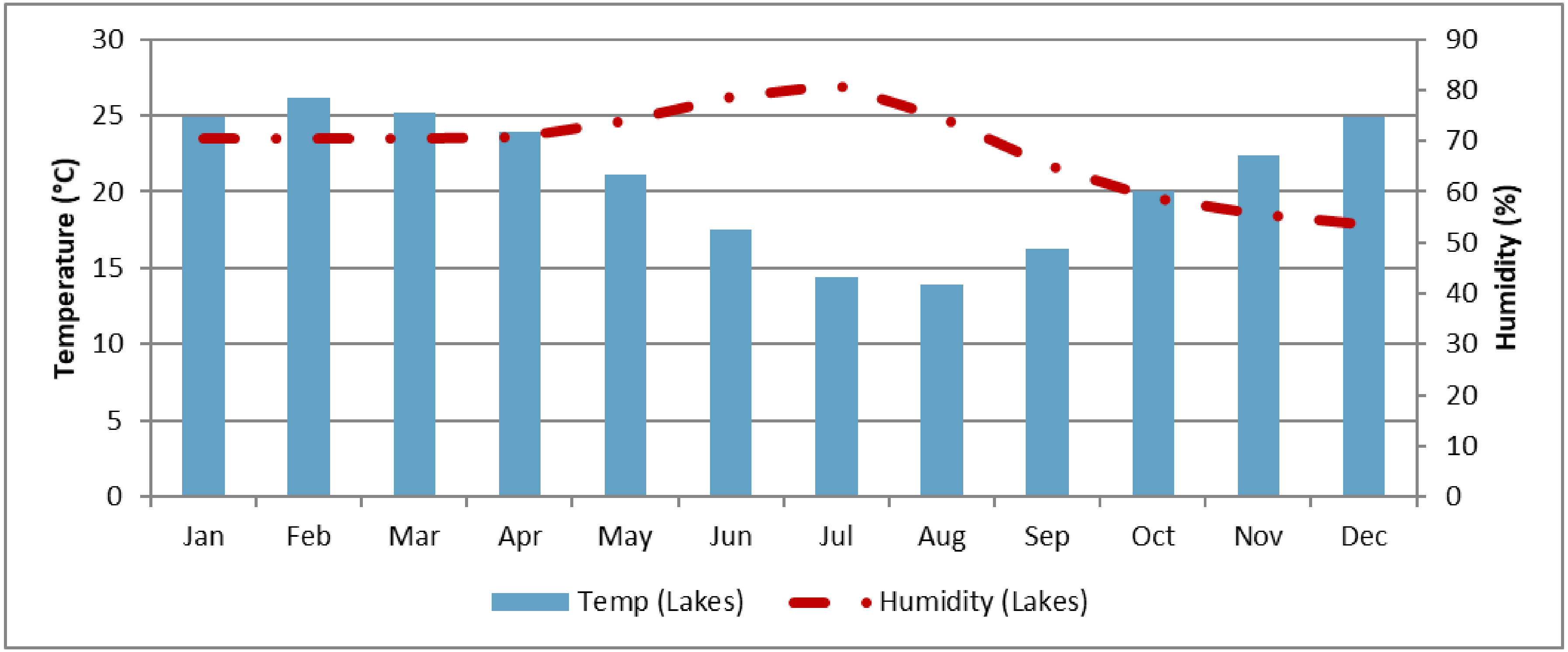


Figure 5-3: Monthly Temperature Averages and Humidity

(Source: Lakes Environmental)

5.1.1.4. Wind Speed

Hourly meteorological data was analysed and used to understand the prevailing wind patterns at the MRA. Data was used to assess the wind speed and wind direction regime on site.

The wind rose is depicted in Figure 5-4. The prevailing winds are from the northeast (25%) and east-northeast (25%) respectively. The wind directions for the different seasons, and during the day were relatively constant to the annual wind rose pattern, with winds from the northeast and east-northeast dominating. Secondary winds were observed from the east (10%) and north-northeast (8%) respectively.

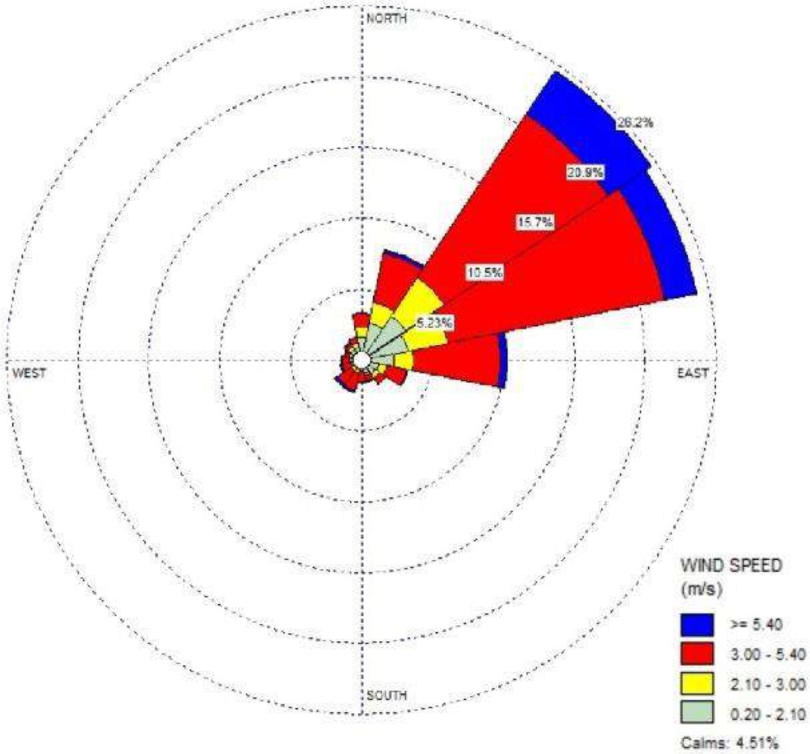


Figure 5-4: Surface wind rose

(Source: Lakes Environmental)

The average wind speed at the MRA is 3.1 m/s and calm conditions (<0.5 m/s) occurred for some 5.4% of the time. Wind speed capable of causing wind erosion i.e. ≥5.4 m/s occurred for about 7.3% of the time (Figure 5-5). This equates to about 27 days in a year.

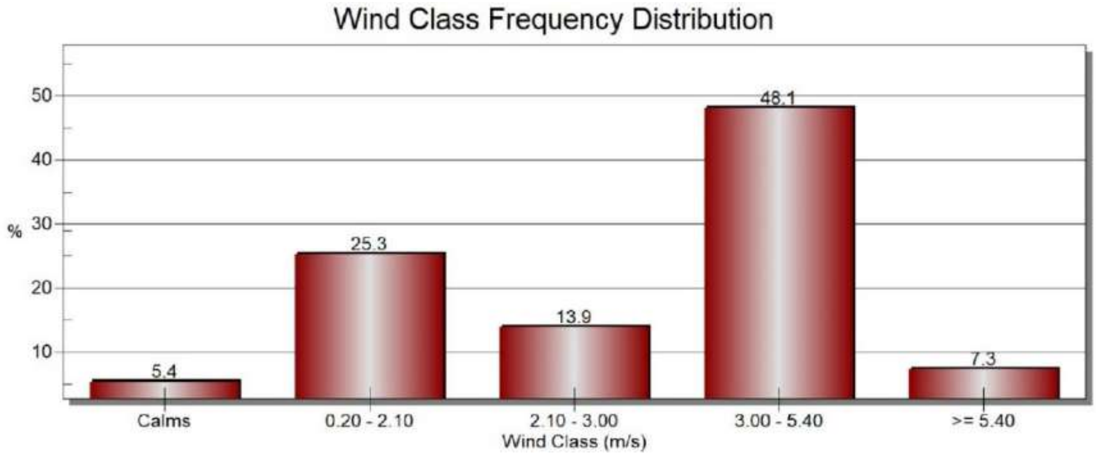


Figure 5-5: Wind Class Frequency

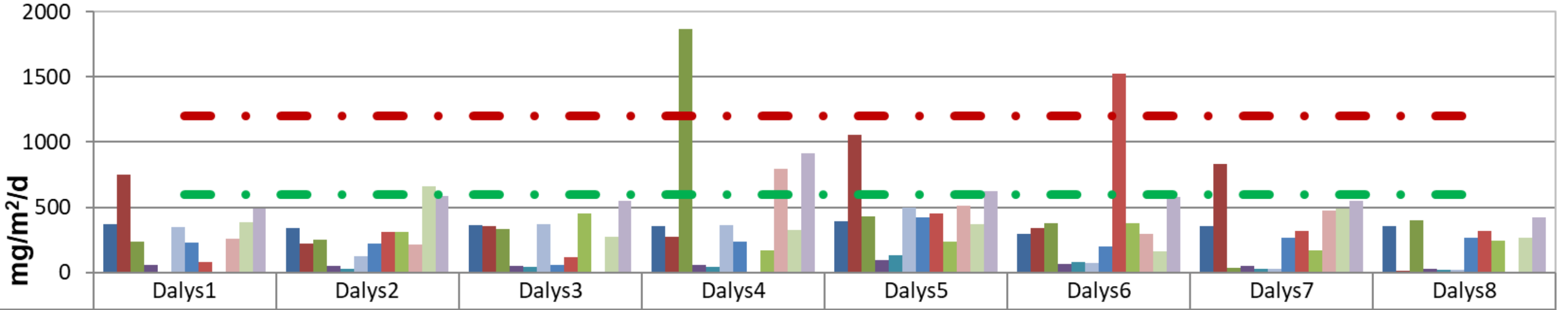
(Source: Lakes Environmental)

5.1.2. Assessment of Existing Air Quality

5.1.2.1. Total Suspended Particulate

Historical dustfall records collected using the American Standard Test Method (ASTM) D1739 were used to assess background TSP scenarios in the MRA. One years' worth of dustfall data from eight sites (designated as Dalys 1 to Dalys 8) were used. The graph showing the results is depicted below (Figure 5-6). Since mining has not commenced, the monitoring sites were categorised as residential. Once mining commences, the sites will be reclassified as non-residential. The dustfall results were compared with the dust standards (GN 827 of 2013). For a site where exceedance of the residential limit was observed, the reasons for the exceedance are provided after an investigation was conducted in sequential order:

- Dalys 1: exceedance was observed in April 2013 (751 mg/m^{2}d);
- Dalys 2: exceedance was observed in January 2014 (661 mg/m^{2}d);
- Dalys 4: exceedances were observed in May 2013 (1,871 mg/m^{2}d), October 2013 (8,441 mg/m^2/d), December 2013 (792 mg/m^{2}d), and February 2014 (915 mg/m^{2}d). The October result was omitted, as this was considered sabotage. These are exceedances above the residential and non-residential limit values. Investigation of these sites found that cattle were being transferred from one area to another. This localised activity resulted in particulates being airborne, deposited, and re-suspended. This lead to the high dustfall rates measured at these sites;
- Dalys 5: exceedances were observed in April 2013 (1,055 mg/m^{2}d), and February (627 mg/m^{2}d);
- Dalys 6: exceedance was observed in October 2013 (1,524 mg/m^{2}d); and
- Dalys 7: exceedance was observed in April 2013 (829 mg/m^{2}d).



	Dalys1	Dalys2	Dalys3	Dalys4	Dalys5	Dalys6	Dalys7	Dalys8
Mar-13	369	343	360	356	396	295	358	355
Apr-13	751	218	353	275	1055	338	829	14
May-13	235	253	336	1871	429	381	35	397
Jun-13	59	49	47	56	91	67	50	26
Jul-13	6	29	44	44	128	80	31	20
Aug-13	345	122	371	363	497	75	31	20
Sep-13	231	219	54	236	422	201	263	263
Oct-13	78	312	120		449	1524	321	316
Nov-13		311	449	168	237	377	169	246
Dec-13	255	217		792	513	298	471	
Jan-14	382	661	272	322	368	163	489	265
Feb-14	492	588	552	915	627	576	551	420
Residential Limit	600	600	600	600	600	600	600	600
Non-Residential Limit	1200	1200	1200	1200	1200	1200	1200	1200

Figure 5-6: Dalyshope Dustfall Data

5.1.2.2. Particulate Matter and Gases

The real-time air quality monitor was installed at a secure location in the MRA to collect data for one month. A picture of the real-time continuous monitor and the range of pollutants measured is depicted in Figure 5-7. Criteria air pollutants retrieved from the real-time sampler include PM_{10}, NO_2, SO_2, and CO. The data is recorded in the comma-separated values (CSV) format that can be directly imported into Microsoft® Excel for statistical analysis and interpretation.

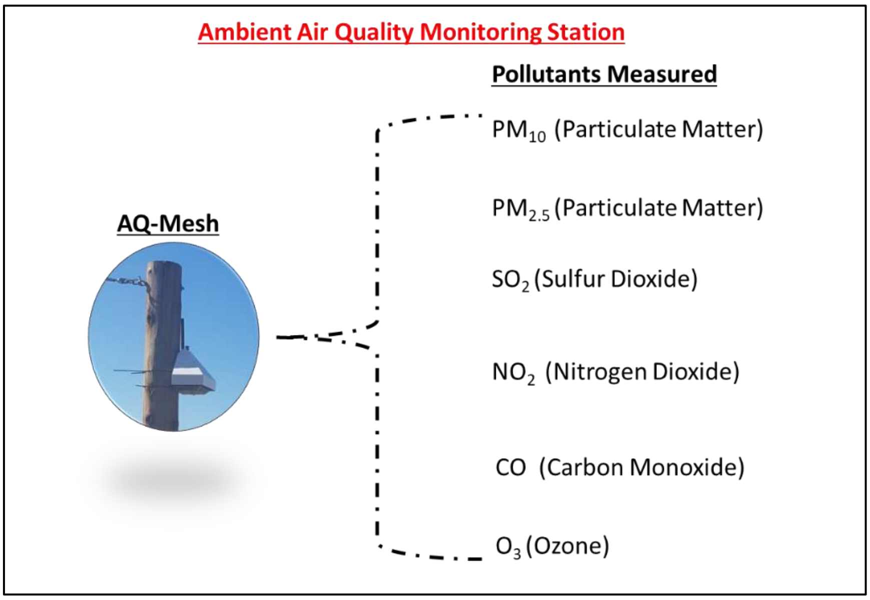


Figure 5-7: Schematic of the Pollutants Measured

5.1.2.2.1. Fine Particulate Matter

The monitoring of these pollutants ensures background levels are established before the commencement of mining. The background levels of PM_{10} and $PM_{2.5}$ measured were very low. For PM_{10}, the highest daily concentration measured during the sampling period was 4.5 µg/m^3. This value is approximately 6% of the South African standard (75 µg/m^3). For $PM_{2.5}$, the highest daily concentration measured was 3.1 µg/m^3. This value is approximately 8% of the South African standard (40 µg/m^3). The graphs showing the plot of the data compared with the standards are depicted in Figure 5-8 and Figure 5-9.

5.1.2.2.2. Gaseous Pollutants

The ambient concentrations of SO_2, NO_2, and CO are displayed graphically in Figure 5-10, Figure 5-11, and Figure 5-12.

For SO_2, the highest daily concentration measured was 4.5 µg/m^3. This value is 4% of the South African standard (125 µg/m^3).

For NO_2, the highest hourly concentration measured was 76 μg/m³. This value is 38% of the South African standard (200 μg/m³).

For CO, the highest hourly concentration measured was 313 μg/m³. This value is approximately 1% of the South African standard (30,000 μg/m³).

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

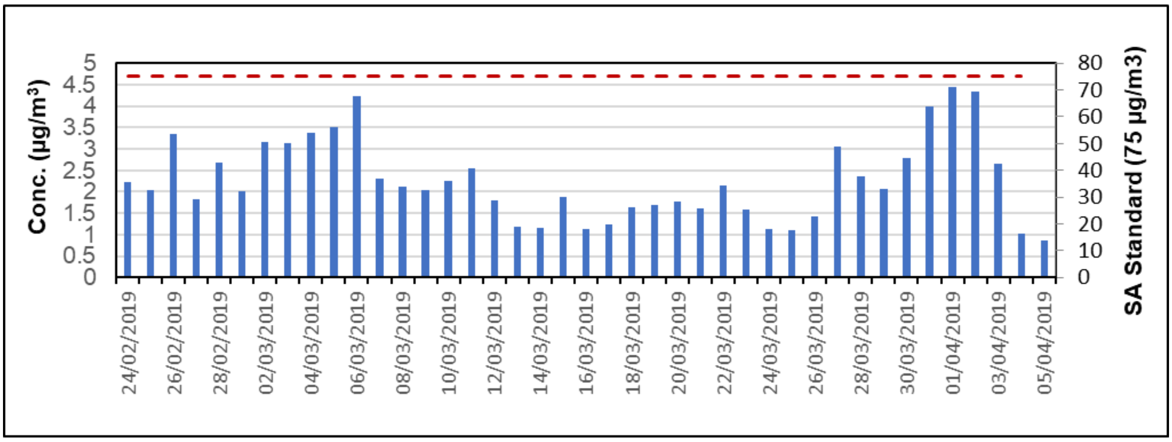


Figure 5-8: Ambient Daily PM_{10} Levels in the MRA

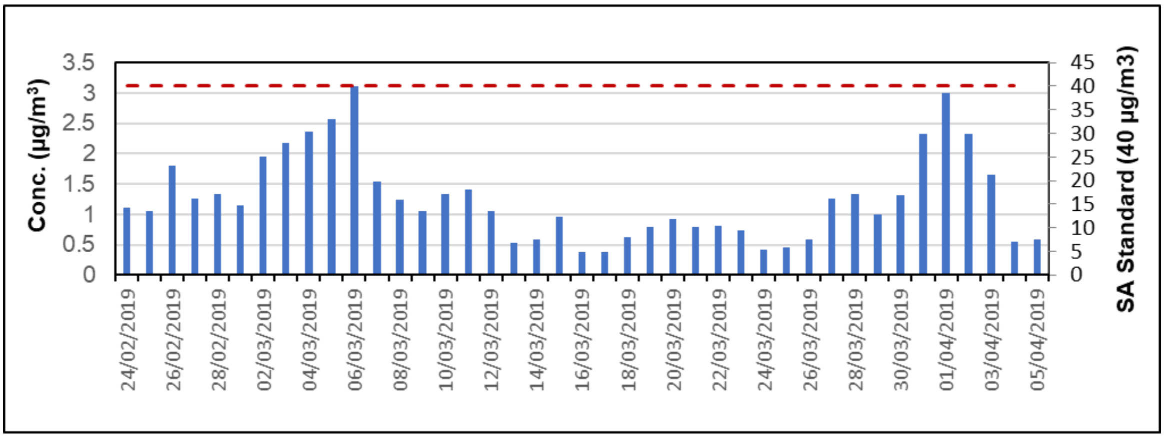


Figure 5-9: Ambient Daily $PM_{2.5}$ Levels in the MRA

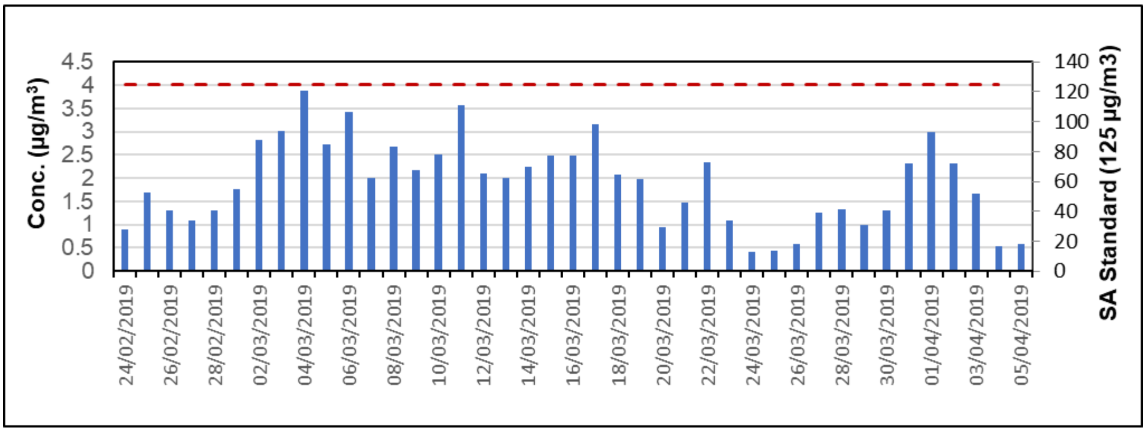


Figure 5-10: Ambient Daily SO_2 Levels in the MRA

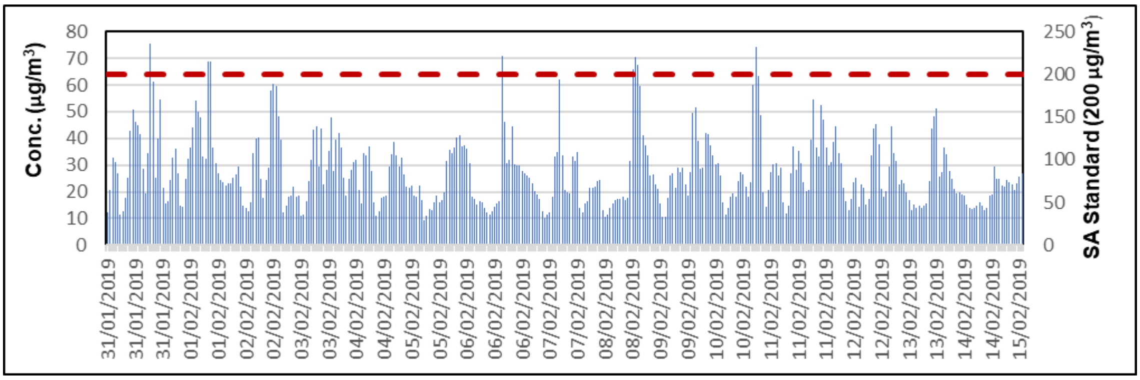


Figure 5-11: Ambient Hourly NO_2 Levels in the MRA

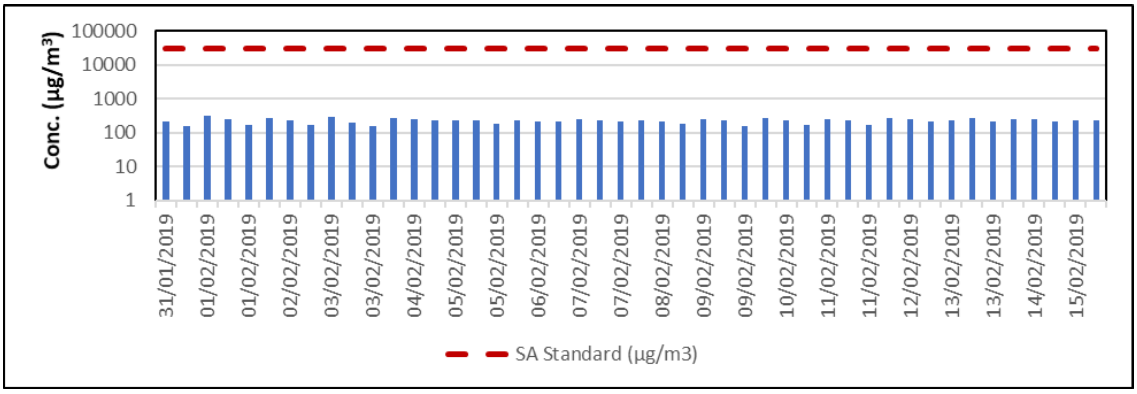


Figure 5-12: Ambient 8-Hourly CO Levels in the MRA

5.2. Air Quality Impact Assessment

The NEM:AQA regulation regarding Air Dispersion Modelling (GN R 533 of 2014) informed the assessment approach. A Level 3 assessment was used, which required detailed meteorological geophysical and source input data.

5.2.1. Impact Assessment Approach

The approach used to determine the future impacts from the operational phase of the Project and related activities is provided in Figure 5-13.

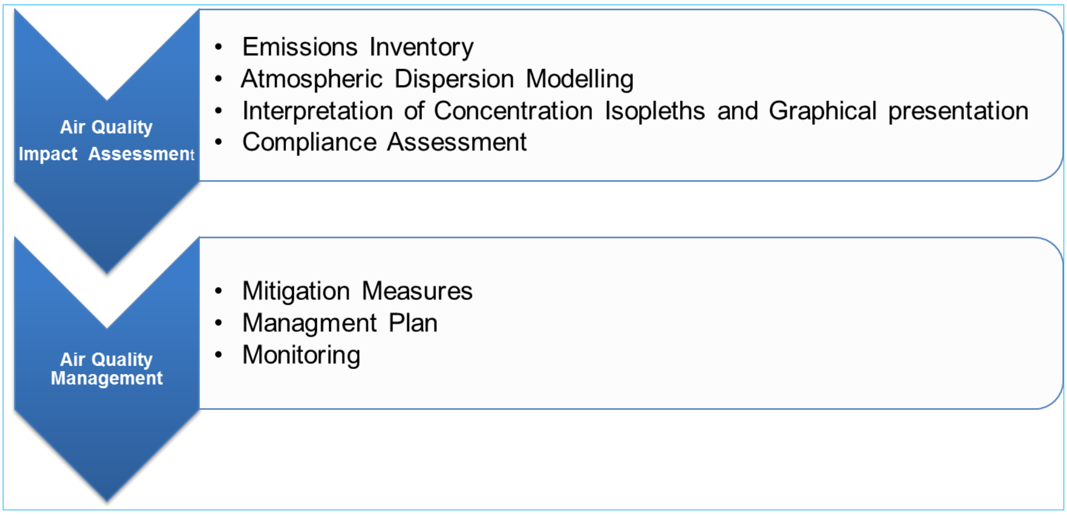


Figure 5-13: Air Quality Impact Assessment Methodology

During the impact assessment, tasks to be completed included the development of an emissions inventory, followed by model simulations to predict GLC of criteria pollutants. The model outputs were used to assess compliance with regulatory standards and inform the mitigation measures and management recommended, as well as monitoring requirements to assess the efficiency of the mitigation measures.

5.2.1.1. *Emissions Inventory*

The development of an emissions inventory forms the basis for any conceptual model. 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 that have been established at similar operations. The latter was followed, employing emission factors published by the USEPA in its *AP-42* "Compilation of Air Pollution Emission Factors" (USEPA, 1995; 1998; 2016) and Australian National Pollutant Inventory (*NPi*) "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 the 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 mine during operation are discussed in detail in Table 5-2.

Table 5-2: 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 3.1 m/s was used based on the Lakes Environmental data for the period 2017 – 2019.	US-EPA AP42 Section 13.2.4	<u>The moisture content of the materials are as follows:</u> Topsoil Stockpile: 4.5% (MWP, 2020) 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 traveled (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 traveling the road = 40 t side truck	US-EPA AP42 Section 13.2.2	Default silt content: Mine Road: 6.9% Hours of operation were assumed as 24 hrs per day, 7 days per week. The capacity of the haul trucks to be used was given as a 91.7 metric t truck (Komatsu HD785).

Activity	Emission Equation	Source	Information assumed/provided
	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 The empirical constant (b) is given as 0.45 for $PM_{2.5}$, PM_{10}, and TSP		The layout of the haul roads was assumed to be 20 m wide.
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	Topsoil: 6.9% (Assumed)
Drilling	$0.59 \frac{kg}{hole}$	NPi 1999	
Blasting	$0.000014(A)^{1.5}$	USEPA, 1998	Blasting three times a week (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: Topsoil: 6.9% (Assumed) U = mean wind speed in m/s M = moisture content in %
Generator	PM_{10}: 6.5 mg/Nm^3 NO_2: 2816 mg/Nm^3 CO: 459 mg/Nm3	CAT 4000 KVA	Parameters applied: Exit temperature:469.7°C Exit Velocity: 16.3 m/s Release height: 10 m Volumetric flow rate: 38,8 m^3/s

5.2.1.2. Air Quality Dispersion Modelling and Data Requirements

5.2.1.2.1. Meteorological Data Requirements

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.

An AERMOD modelling system incorporates air dispersion based on 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 mesoscale atmospheric circulation. MM5 modelled meteorological data set for full three calendar years was obtained from Lakes. This dataset consists of surface and upper air meteorological data required to run the dispersion model.

5.2.1.2.2. Modelling Domain

The AERMAP terrain pre-processor requires the user to define a modelling domain. The modelling domain is defined as the area that contains all the receptors and sources being modelled with a buffer, to accommodate any significant terrain elevations.

The influence of the terrain will vary with the source height and position and the local meteorology. Table 5-3 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: Digital elevation model 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:
  - Model inputs: source parameters (from permit application); boundary layer meteorology (from AERMET); and receptor data (from AERMAP).

Table 5-3: Summary of Meteorological and AERMET Parameters

Number of grids (spacing)	200 m
Number of grids points	121 x 121
Years of analysis	January 2017 to December 2019
Centre of analysis	Lephalale (23.555425 S; 23.236997 E)
Meteorological grid domain	20 km (east-west) x 20 km (south-north)
Station Base Elevation	859 m

MM5-Processed Grid Cell (Grid Cell Centre)	23.555425 S; 23.236997 E
Anemometer Height	14 m
Sectors	The surrounding area land use type was Bushveld
Albedo	0,33
Surface Roughness	0,27
Bowen Ratio	4,8
Terrain Option	Flat

5.2.1.3. Impact Assessment Ranking

Based on the predicted GLC of various pollutants and the spread across the mining landscape, the impact assessment ranking methodology in Appendix A was applied in rating impacts of the project on the surrounding air quality.

6. Findings and Discussion

6.1. Baseline Results

The meteorology of the MRA assessed with 3-years' worth of data, revealed that the predominant winds are from the northeast and east-northeast respectively. The average wind speed observed was ~3.1 m/s, while winds greater than 5.4 m/s occurred for 7.3% of the time.

The dustfall rates measured in the proposed project area have shown that exceedances of the residential and non-residential limits were limited to locations near cattle feed pens. A total of 10 exceedances of the residential limit were measured i.e. at Dalys 01 (1), Dalys 2 (1), Dalys 4 (4), Dalys 5 (2), Dalys 6 (1) and Dalys 7(1). With regards to the non-residential exceedances, only two were recorded, at Dalys 4(1) and Dalys 6(1). The sites with exceedances were in the vicinity of cattle feedlot, hence the high dustfall rates measured. The results show that the 90th percentile of the data recorded over the 12 months at eight sites was below 588 mg/m^2/d.

For PM_{10} and $PM_{2.5}$, the highest concentrations measured in the MRA were below 5 µg/m^3 over the one month monitoring period. PM_{10} and $PM_{2.5}$ were at 6% and 8% of their respective limit values.

For the gaseous pollutants, the results show that SO_2, NO_2, and CO concentrations were at 4%, 38%, and 1% of their respective limit values.

6.2. Dispersion Model Simulation Results

The model results consist of a graphical presentation of GLC (in a unit of µg/m^3) for the different pollutants, and dust deposition rates (mg/m^2/d). The daily averages were calculated as the 4th highest value (99th percentile). Annual averages were shown as the 1st highest value (100th percentile).

6.3. Isopleth Plots and Evaluation of Results

6.3.1. Predicted GLC of $PM_{2.5}$

The predicted GLC of $PM_{2.5}$ over a 24-hour averaging period for the operational phase returned simulation isopleths that are shown in Figure 6-1 ($PM_{2.5}$ daily) and Figure 6-2 ($PM_{2.5}$ annual).

The model simulations show the worst-case scenario (assuming no mitigation measures were put in place at the mine). The areas with predicted exceedances of the 24-hour standard (40 µg/m³) are mostly confined within the MRA (Figure 6-1). The GLC at the nearby sensitive receptors (SR 1) and (SR 2) will be lower than the standard (Table 6-1). The annual GLC of $PM_{2.5}$ predicted will not exceed the regulatory standard, as the GLC predicted to vary between 10 µg/m³ and 20 µg/m³ (Figure 6-2).

6.3.2. Predicted GLC of PM_{10}

The predicted GLC of PM_{10} over a 24-hour averaging period returned simulation isopleths shown in Figure 6-3 (PM_{10} daily) and Figure 6-4 (PM_{10} annual).

Areas, where the South African 24-hour standard of 75 µg/m³ will be exceeded, are within the MRA and adjacent areas, some 1.0 km to the east, north, and west from the MRA boundary (Figure 6-3). The GLC at the nearest sensitive receptors SR 1 was higher than the standard (Table 6-1). At SR2, the predicted GLC will be lower than the standard. The predicted annual isopleth showed that areas where exceedance will occur are confined to within the MRA during operation (Figure 6-4). The annual GLC predicted at the selected sensitive receptors SR 1 and SR 2 were below the South African standard (Table 6-1).

6.3.3. Predicted Dustfall Rates

The predicted dustfall rates from the model simulation are shown in Figure 6-5 (no mitigation) and Figure 6-6 (with mitigation). The predicted dustfall rates confirmed that the non-residential limit of 1,200 mg/m²/d will be exceeded within the MRA and adjacent areas (especially adjacent areas in the southwest direction). Dustfall rates at the nearby receptors SR 1 and SR 2 were lower than both the residential and non-residential limit values of 600 mg/m²/d and 1200 mg/m²/d without mitigation measures in place (Table 6-1). However, with mitigation measures factored into the model, the dustfall rates were reduced, with areas with exceedance confined within the MRA boundary (Figure 6-6).

6.3.4. Predicted NO_2 GLC

The NOx (as NO_2) 1-hr GLC show exceedances of the South African standard of 200 µg/m³ mostly confined within the MRA. However, model prediction shows that areas southwest (some 1.1 km downwind) will experience exceedances (Figure 6-7). Being a gas, this pollutant will dissipate quickly to negligible levels further away from the MRA.

6.3.5. Predicted SO_2 GLC

Model predictions confirm that the SOx (as SO_2) 24-hr GLC will be very low and unlikely to exceed the South African standard of 200 µg/m³ (Figure 6-8 andTable 6-1).

6.3.6. Predicted CO GLC

Model simulations returned predicted CO 8-hr GLC that will not exceed the South African standard of 10,000 µg/m³ within the MRA and at the surrounding sensitive receptors. During the operational phase, the exceedance of the regulatory limit is not anticipated due to the low GLC predicted.

Table 6-1: Predicted Concentrations of PM_{10}, $PM_{2.5}$ and Dust Deposition Rates at Selected Sensitive Receptors

Pollutants	Averaging Period	South Africa Air Quality Standard ($\mu g/m^3$)	Predicted Ground Level Concentration ($\mu g/m^3$)	
			SR 1	SR 2
PM_{10} (No Mitigation)	Daily	75(1)	110	25
	Annual	40(1)	6	1.5
$PM_{2.5}$ (No Mitigation)	Daily	40(1)	24	5
	Annual	20(1)	0.9	0.2
Dust Deposition Rates ($mg/m^2/day$)				
Dust (No Mitigation)	Monthly	Residential (600(2)) Non-residential (1200(2))	70	55
Dust (With Mitigation)			11	7

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

Table 6-2: Predicted Concentrations of NO_2, CO at Selected Sensitive Receptors

Pollutants	Averaging Period	South Africa Air Quality Standard (µg/m³)	Predicted Ground Level Concentration (µg/m³)	
			SR1	SR2
NO_2 (No Mitigation)	1 hour	200(1)	61	56
SO_2 (No Mitigation)	Daily	125(1)	0.9	1.2
South Africa Air Quality Standard (µg/m³)				
CO (No mitigation)	8 hours	10000(2)	23	20

1. South African National Ambient Air Quality Standards, 2009;2012

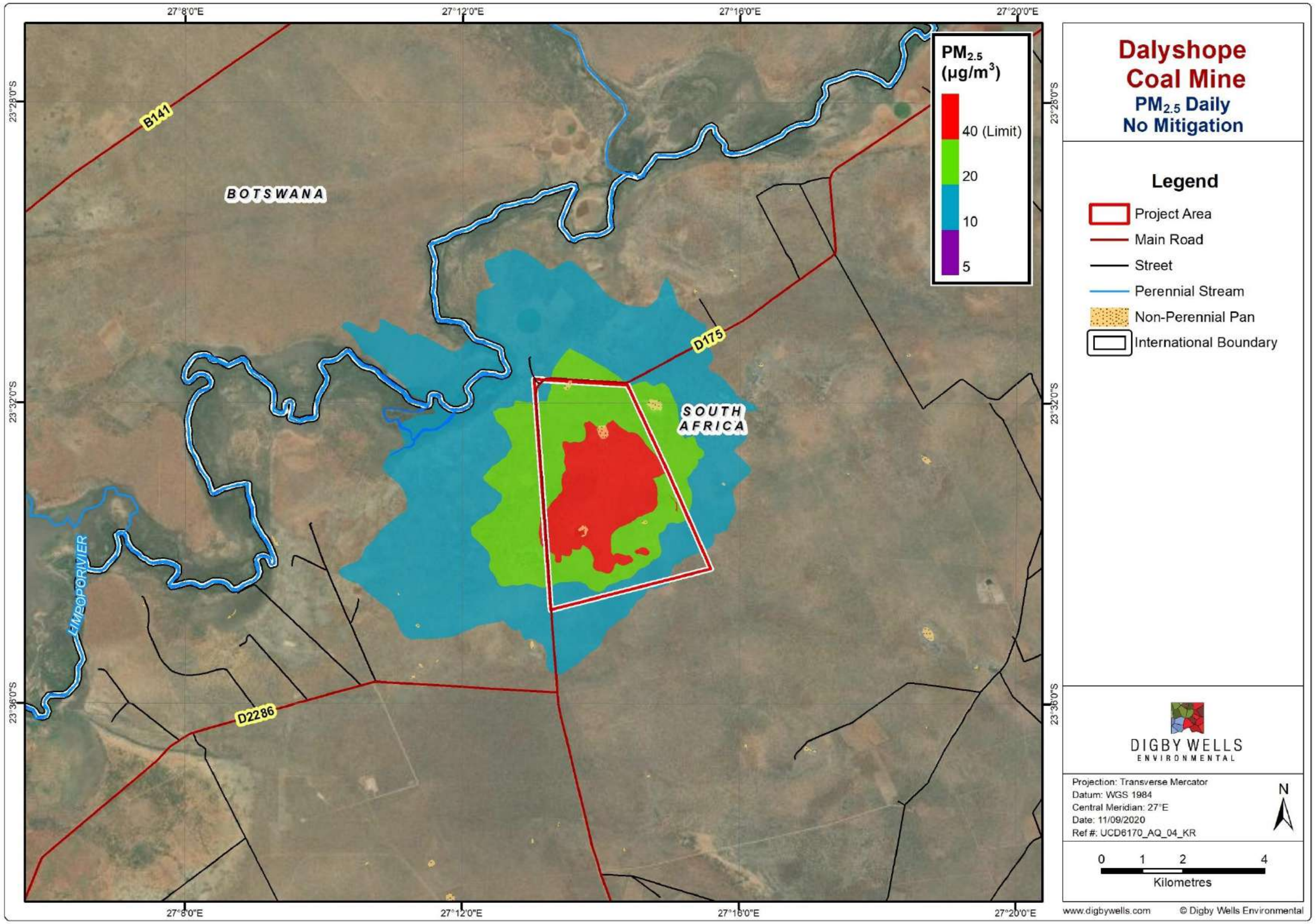


Figure 6-1: Predicted 4th highest (99th percentile) daily $PM_{2.5}$ Concentrations (µg/m³)

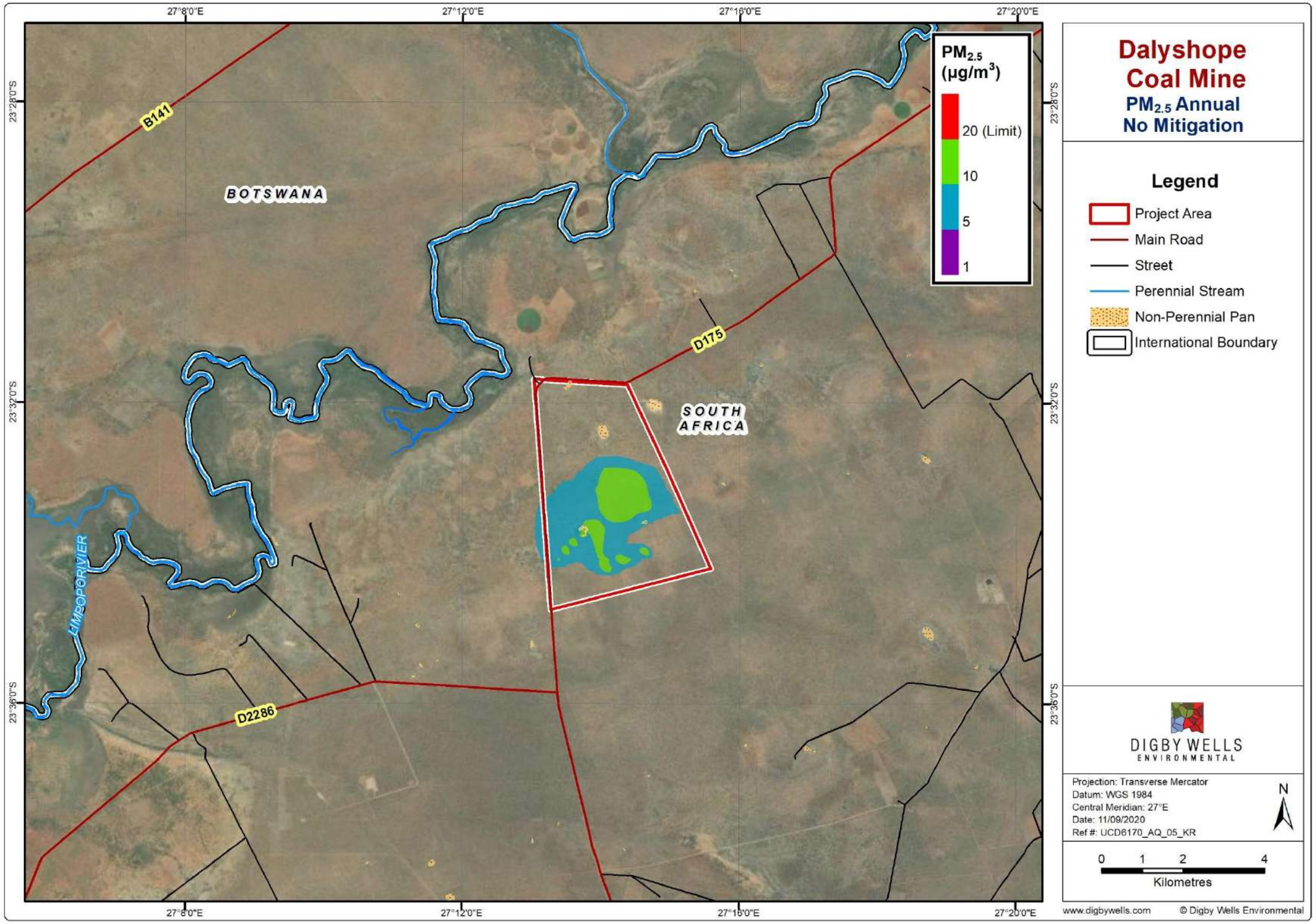


Figure 6-2: Predicted 1st highest (100th percentile) Annual PM2.5 Annual Concentrations (µg/m³)

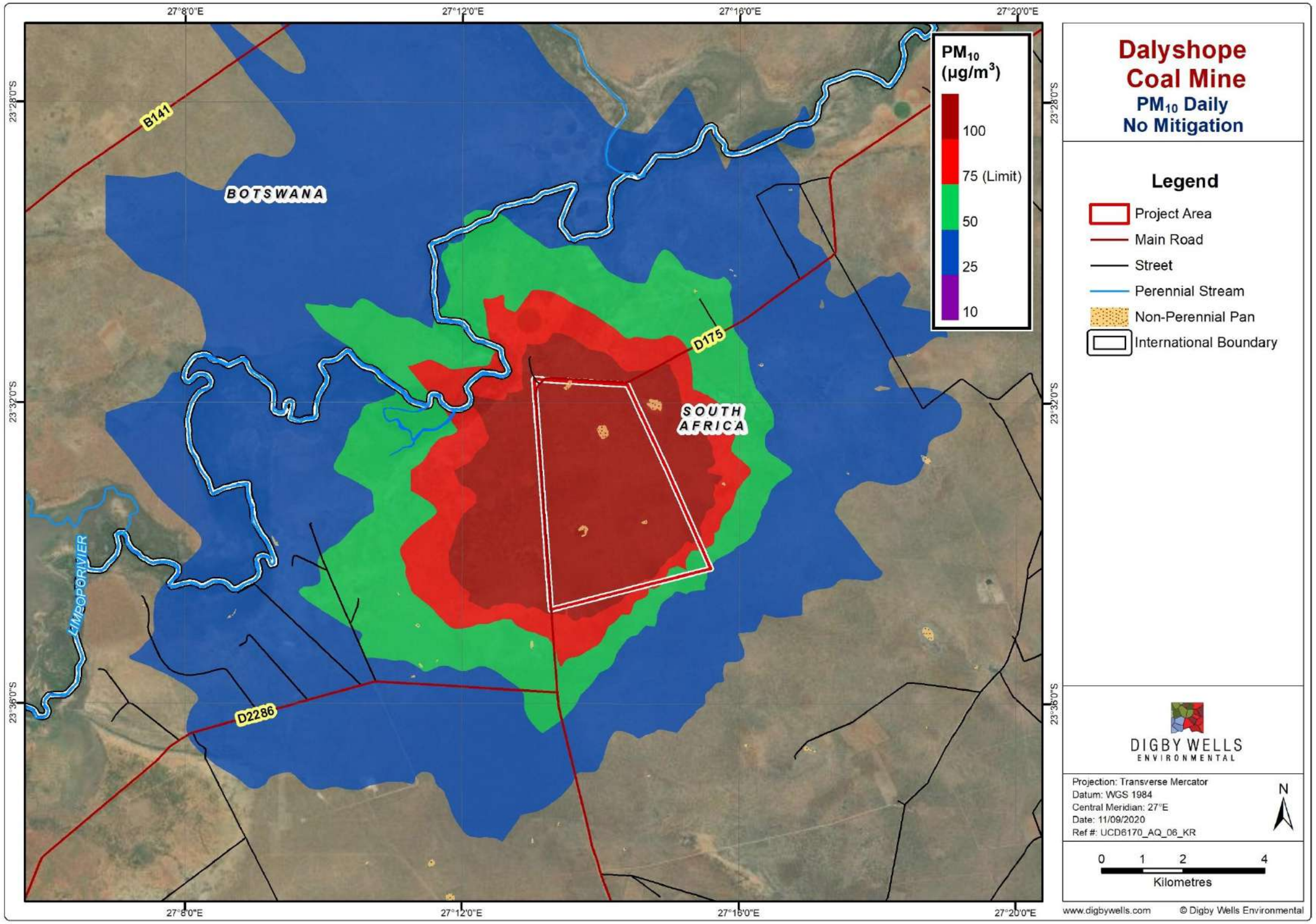


Figure 6-3: Predicted 4th highest (99th percentile) daily PM_{10} Concentrations (µg/m³)

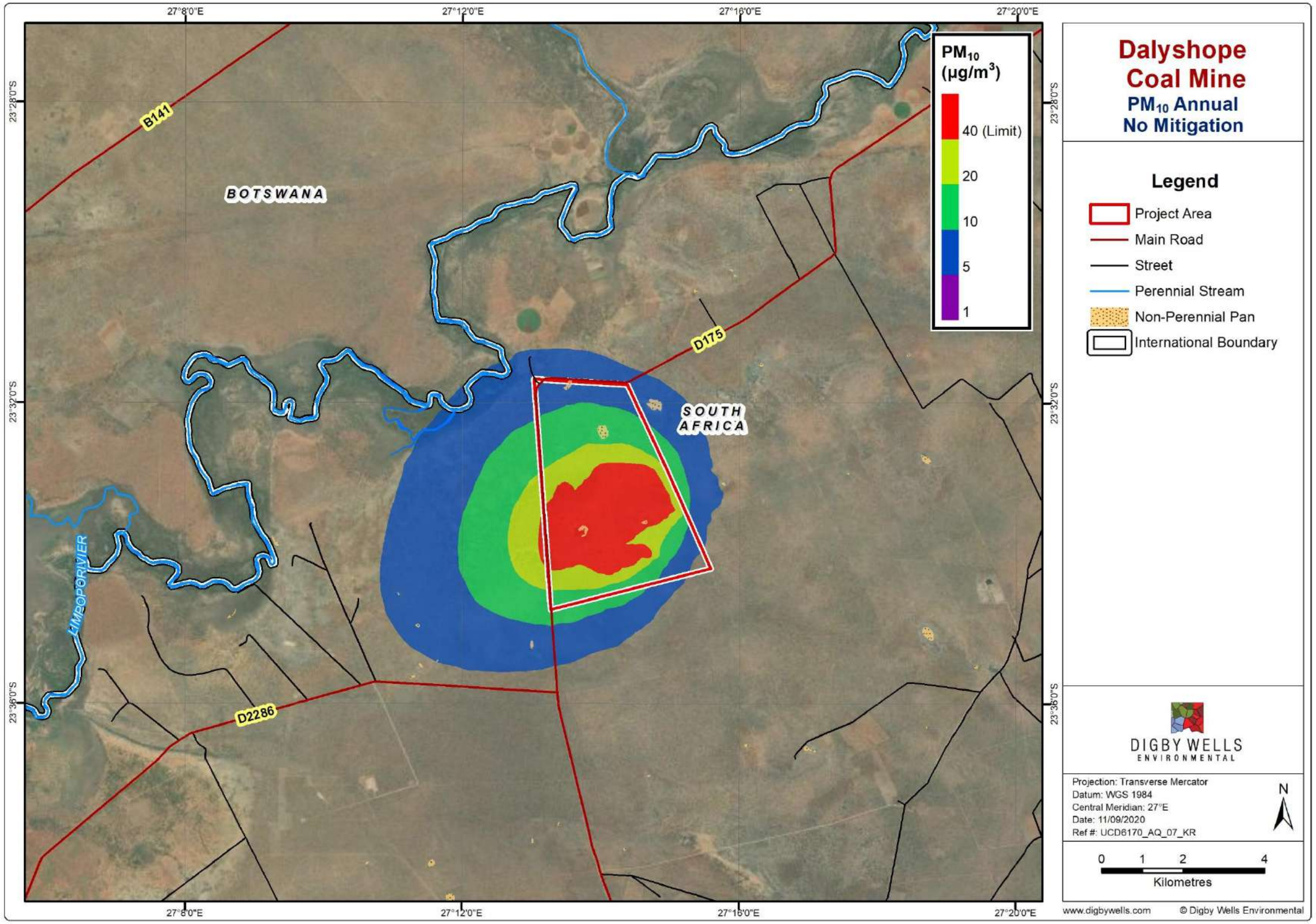


Figure 6-4: Predicted 1st highest (100th percentile) Annual PM_{10} Concentrations (µg/m³)

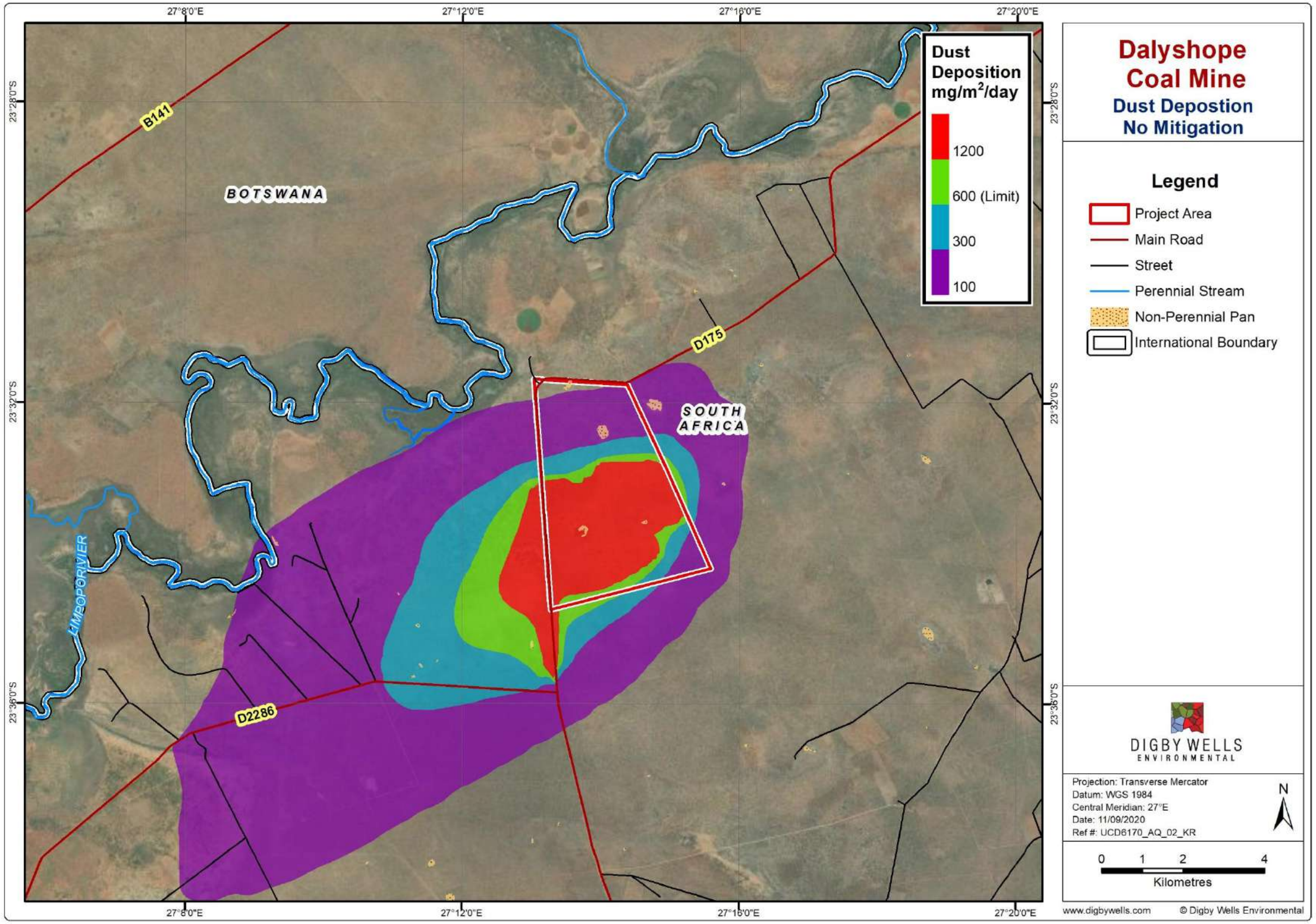


Figure 6-5: Predicted (100th percentile) Monthly TSP Deposition Rates (mg/m²/day) No Mitigation

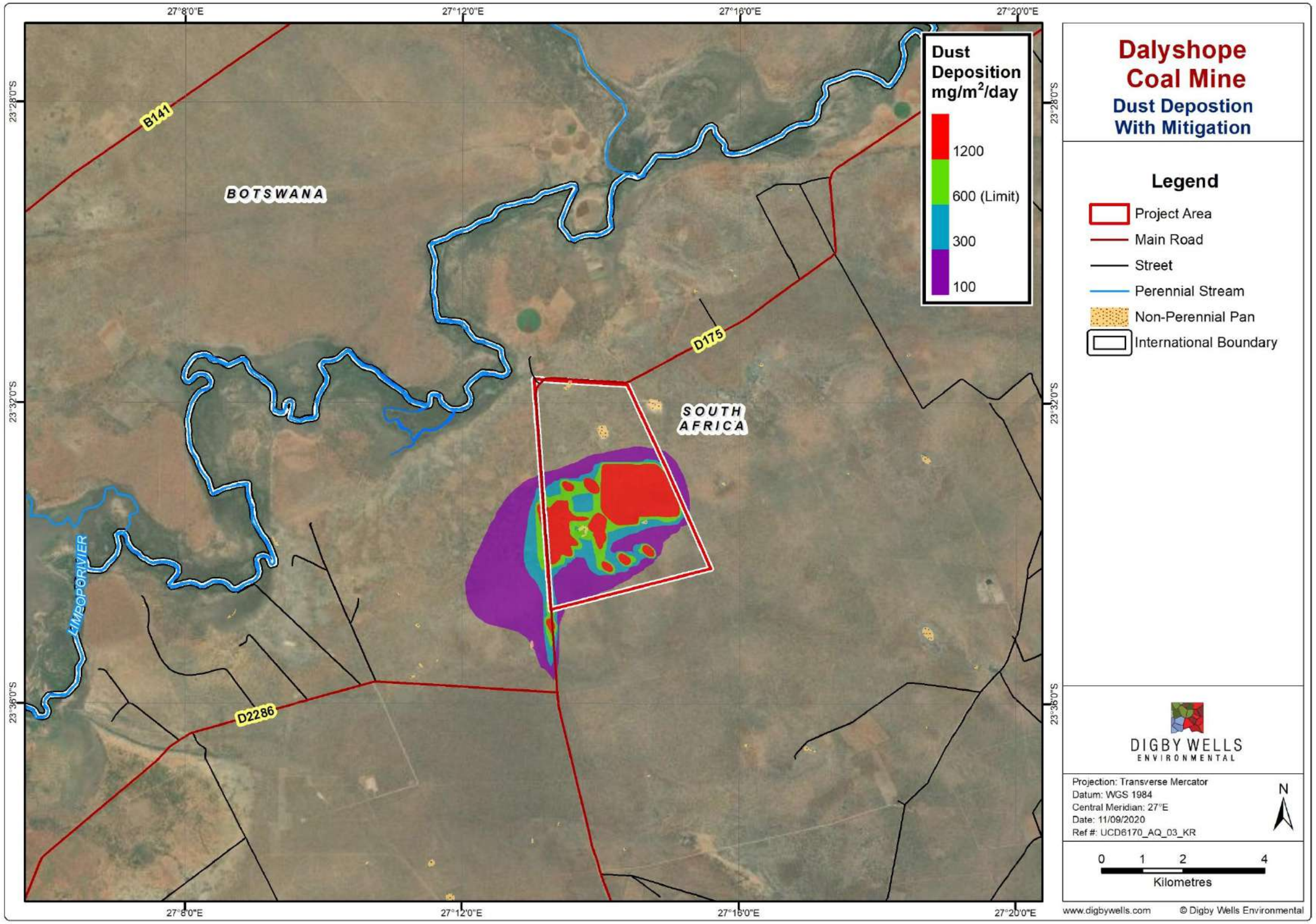


Figure 6-6: Predicted (100th percentile) Monthly TSP Deposition Rates (mg/m²/day) With Mitigation

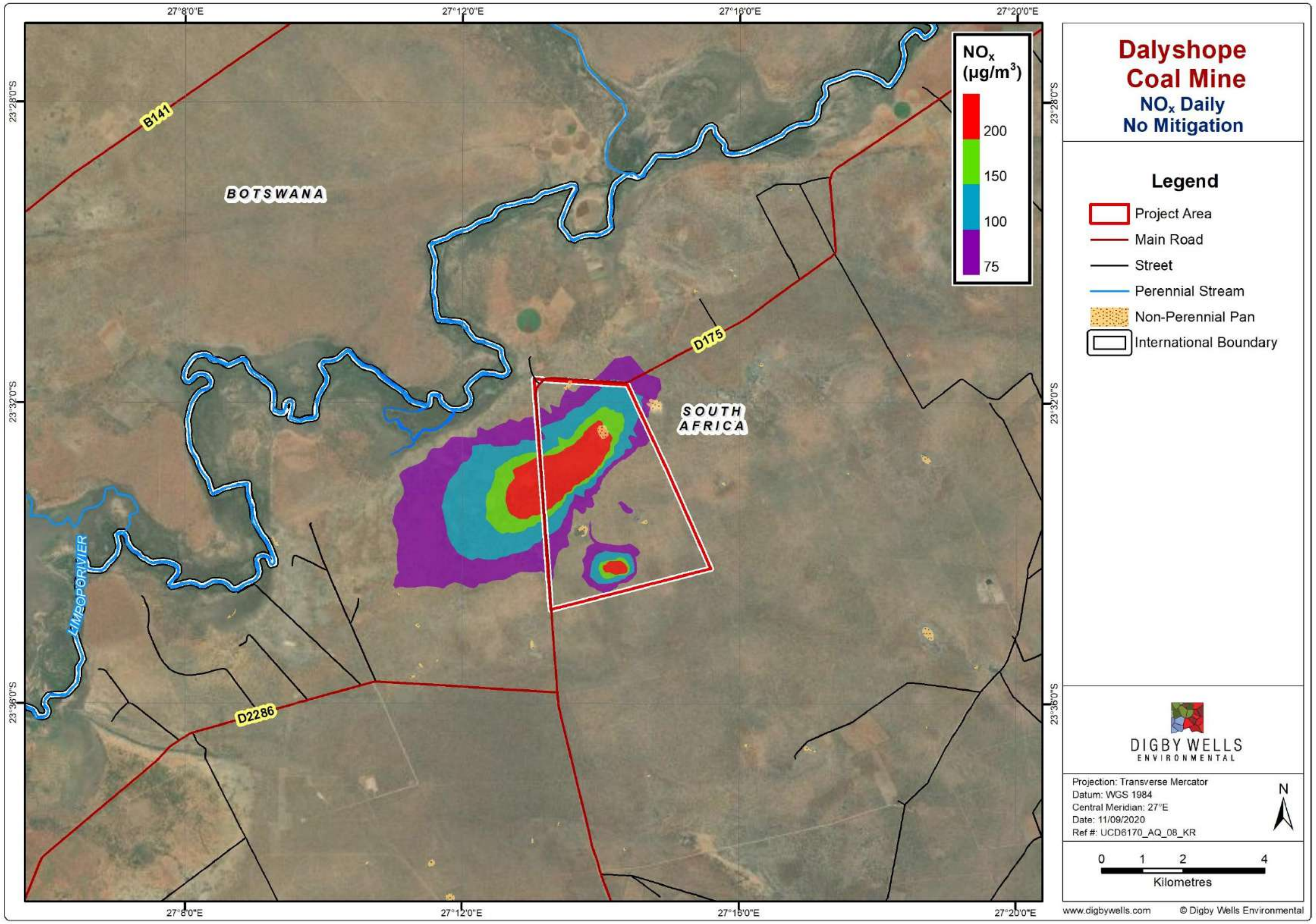


Figure 6-7: Predicted NO_2 1-hr Concentrations (µg/m³)

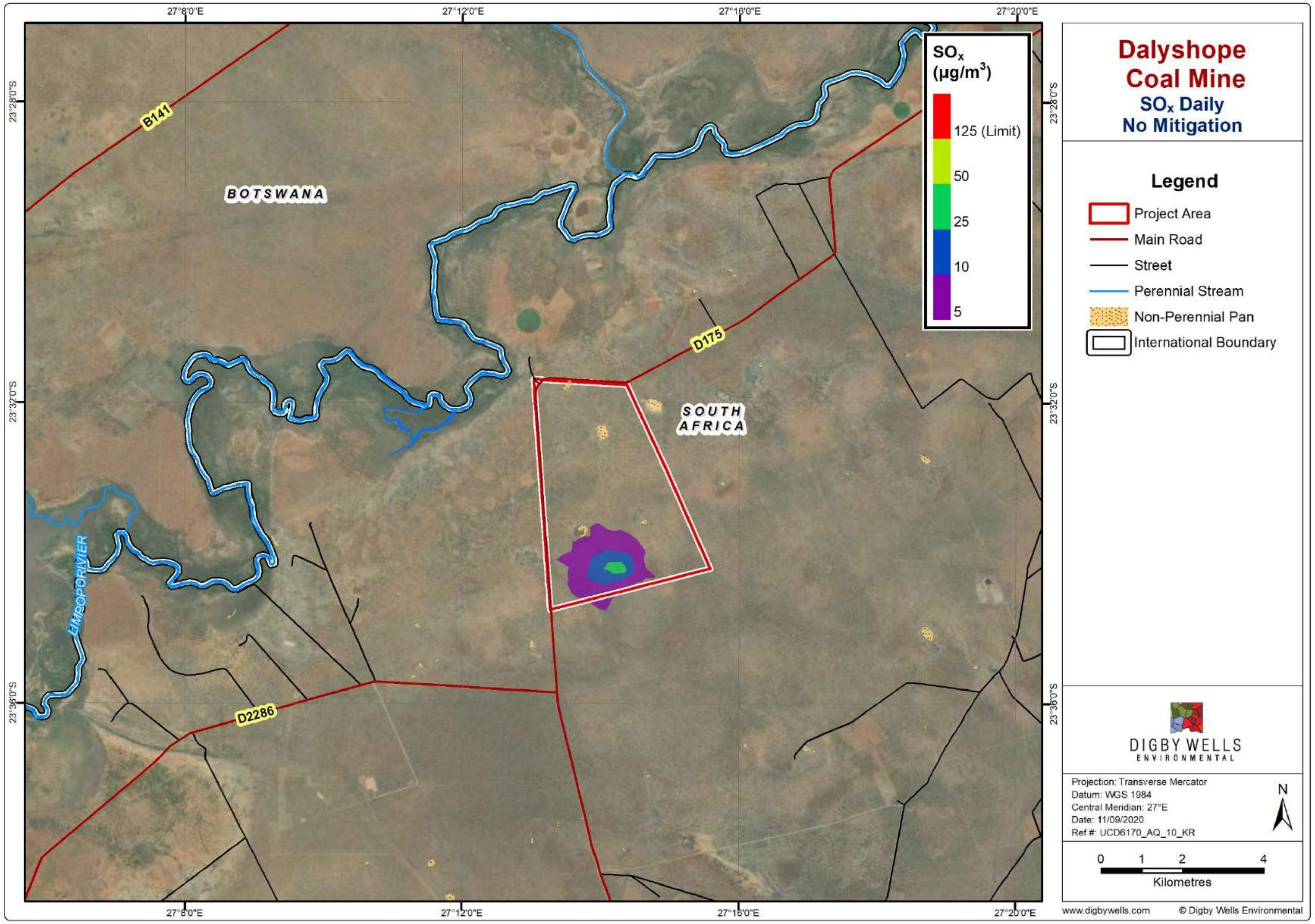


Figure 6-8: Predicted SO_2 24-hr Concentrations (µg/m³)

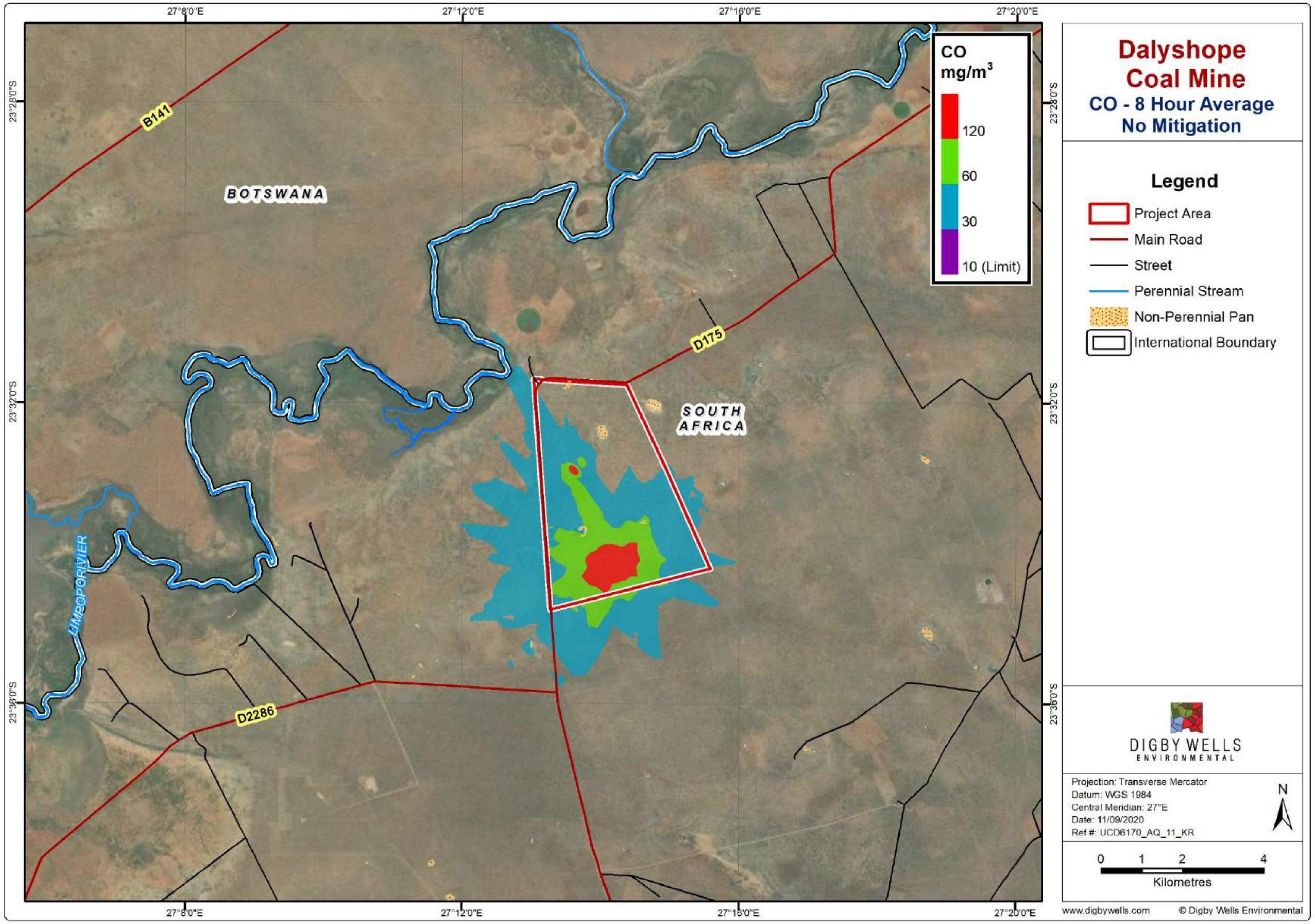


Figure 6-9: Predicted CO 8-hr Concentrations (µg/m^3)

7. Discussions

The potential GLC predicted for the MRA due to the operational phase of the Project have been appraised.

7.1. Findings

The findings presented represent the worst-case scenario, i.e. without mitigation measures factored in the model runs, except for the dustfall. The findings of this air quality study are summarised as follows:

- The predicted GLC of $PM_{2.5}$ over a 24-hr averaging period shows that there will be exceedances of the South African standard of 40 µg/m. The area where these exceedances will be observed will be confined to the MRA. The GLC predicted for the nearby sensitive receptor locations SR 1 and SR 2 were below the daily limit. The predicted GLC of $PM_{2.5}$ annual average was below the South African standard of 20 $\mu g/m^3$ within the MRA and at nearby sensitive receptors.
- The predicted GLC of PM_{10} over a 24-hr averaging period has confirmed that exceedances of the South African standard of 75 $\mu g/m^3$ will occur. These exceedances are mostly confined within the MRA, but adjacent areas some 1.0 km to the east, north, and west of the MRA boundary will be affected. The predicted GLC of PM_{10} annual shows that areas with exceedances will be confined to the MRA. As a result, the GLC at the nearby sensitive receptors were below the South African standard of 40 $\mu g/m^3$.
- Isopleths of the predicted dustfall rates show that exceedances of the non-residential limit of 1,200 $mg/m^2/d$ will occur within the MRA and adjacent areas in the southwest direction (downwind). When mitigation was factored into the model run, the areas with exceedance were confined to the MRA. The predicted levels at the sensitive receptors were below the residential and non-residential limits.
- The predicted GLC of NO_2 1-hr shows that exceedance of the South African standard of 200 $\mu g/m^3$ will be experienced within the MRA and adjacent areas to the southwestern boundary. The predicted NO_2 1-hr GLC will be lower than the report once mitigation measures are implemented. The GLC at the nearby receptors were compliant with the standard.
- The predicted GLC of SO_2 over a 24-hr averaging period shows that exceedance of the South African standard of 125 $\mu g/m^3$ is not likely during the operational phase. The isopleth shows that emissions will be confined to the MRA, with negligible influence on surrounding sensitive receptors.
- Model predictions confirmed that the GLC of CO over an 8-hrs averaging period will not exceed the South African standard of 10,000 $\mu g/m^3$ on-site and at sensitive receptors. The predicted levels were very low and insignificant.

8. Impact Assessment Ranking

The impact assessment ranking methodology in Appendix A was applied in rating the implications of the different phases of the Project on the ambient air quality of the area.

8.1. Construction Phase

Activities during the Construction Phase that may have potential implications on the ambient air quality in the MRA and surroundings i.e. increasing pollutant levels in the atmosphere are indicated in Table 8-1.

Table 8-1: Interactions and Impacts of Activity

Interaction	Impact
Site/vegetation clearance	Generation of dust Increased particulate matter load in the atmosphere leading to poor air quality Soiling of surfaces due to dustfall
Access and haul road construction	
Infrastructure construction	
Topsoil stockpiling / initial cut for mining	
Diesel storage and explosives magazine	Release of volatiles to the ambient atmosphere

8.1.1. Impact Description

Construction of project infrastructure will occur in phases and will be short-term in nature. Therefore, the anticipated impacts will be negligible.

Activities associated with site clearing will result in the generation of fugitive dust comprising of TSP, PM_{10}, and $PM_{2.5}$, especially from construction and use of the haul roads and erosion of open surfaces, construction of infrastructural and topsoil stockpiling. Also, excavation, loading, and tipping of construction material will lead to dust generation. These activities will occur in phases, will be short-term and localised in nature, and will have low impacts on the ambient air quality.

8.1.1.1. Management Objectives

The management objective is to ensure that emissions on-site and at 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.

8.1.1.2. Management Actions

- Particulate monitoring at upwind and downwind locations and sensitive receptors.
- Application of dust suppressants i.e. Dust-A-Side on haul roads and exposed areas to ensure compliance.
- Internal floating roofs and seal to minimize vapourisation from diesel tanks

- Secondary containment for all storage tank leaks in accordance with good engineering.

8.1.1.3. Impact Ratings

The construction phase activities will require similar mitigation measures to contain emissions to the atmosphere, hence in the impact rating these activities are grouped for ranking (Table 8-2) and separate for diesel storage (Table 8-3).

Table 8-2: Significance Ratings for Site Clearing, Construction of Haul Road and Surface Infrastructure, and Topsoil Stockpiling

Activity and Interaction: Site Clearing, Construction of Surface Infrastructure and Topsoil Stockpiling			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Reduction in ambient air quality			
Prior to mitigation/ management			
Duration	Short term (1)	Dust will be generated for the duration of each activity in the construction phase	Negligible (negative) – 30
Extent	Limited (2)	Limited to the project area and immediate surroundings.	
Intensity	Minor (2)	Minor implications on the surrounding area are anticipated	
Probability	Almost certain (6)	There is a possibility that generated dust will impact on ambient air quality.	
Nature	Negative		
Mitigation/ Management actions			
• Application dust suppressant on the haul roads and exposed areas; • Limit activity to non-windy days (wind speed less than 5.4 m/s); • Set maximum speed limits on haul roads and have these limits enforced; • The area of disturbance must be kept to a minimum at all times and no unnecessary clearing, digging or scraping must occur, especially on windy days; • The drop heights when loading onto trucks and at tipping points should be minimised; • The enclosure of crushers; and • Application of fogging system at the crusher.			
Post- mitigation			
Duration	Short term (1)	Dust will be generated for the duration of each activity in the construction phase	Negligible (negative) – 12
Extent	Very Limited (1)	After mitigation measures are implemented, It is expected that the dust generated will be limited to isolated parts of the site.	

Activity and Interaction: Site Clearing, Construction of Surface Infrastructure and Topsoil Stockpiling			
Dimension	**Rating**	**Motivation**	**Significance**
Intensity	Minimal (1)	Generated dust will have negligible impacts on the ambient air quality after mitigation	
Probability	Probable (4)	Probable that the impact on ambient air quality will occur.	
Nature	Negative		

Table 8-3: Significance Ratings for Diesel Storage

Activity and Interaction: Diesel Storage			
Impact Description: Release of Volatiles Resulting in Poor Air Quality			
Prior to mitigation/ management			
Duration	Short term (1)	Vapourisation and leaks from the diesel storage tanks will occur for the duration of the construction phase	Negligible (negative) – 20
Extent	Limited (2)	Vapour released leaks will be limited to the site and immediate surroundings	
Intensity	Minor (2)	Minimal impact on ambient air quality anticipated during the construction phase	
Probability	Probable (4)	Released vapour will probably impact on ambient air quality.	
Nature	Negative		
Mitigation/ Management actions			
• Internal floating roofs and seal to minimize vapourisation. • Spill prevention control and countermeasure plan in place. • Maintenance of large spill kit at the diesel storage facility for incidental spill and drip. • Secondary containment provided for all storage tanks for leaks in accordance with good engineering practices.			
Post management			
Duration	Short term (1)	Vapourisation and leaks from the diesel storage tanks will occur for the duration of the construction phase	Low (negative) – 9

Extent	Very Limited (1)	After mitigation measures are implemented, vapour will be contained.	
Intensity	Minimal (1)	Minimal impact on ambient air quality after mitigation	
Probability	Unlikely (3)	Probable that impacts on ambient air quality will occur.	
Nature	Negative		

8.2. Operational Phase

Activities during the Operational Phase that may have implications on the ambient air quality of the MRA and surroundings i.e. increasing emission to the ambient atmosphere, are indicated in Table 8-4.

Table 8-4: Interactions and Impacts of Activity

Interaction	Impact
Open-pit establishment	Generation of dust Increased particulate matter load in the atmosphere leading to poor air quality Soiling of surfaces due to dustfall
Removal of rock (blasting)	
Operation of the open-pit workings	
Stockpiling (rock dumps, soils, ROM, discard dump) establishment and operation	
Operating processing plant	
Construction of surface infrastructure i.e. pollution control dams	
Storage, handling and treatment of hazardous products (including fuel, explosives and oil) and waste	Vapour released to the atmosphere
Operating sewage treatment plant	Emission of gases to the atmosphere
Diesel storage and explosives magazine	Release of volatiles to the ambient atmosphere

8.2.1. Impact Description

The establishment of the pit and removal, transportation of topsoil, ROM, and overburden material and stockpiling, coupled with the operation of the processing plant with the screening and crusher circuit will result in the emission of particulate matter and gaseous emissions from off-road vehicles. The construction of additional infrastructure i.e. pollution control dam will result in fugitive emissions. These emissions will encompass TSP, PM_{10}, and $PM_{2.5}$.

8.2.1.1. Management Objectives

The management objective is to ensure that emissions on-site and at 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.

8.2.1.2. Management Actions

- Air quality monitoring to ensure compliance at upwind and downwind locations.
- Application of dust suppressants i.e. Dust-A-Side on haul roads and exposed areas to ensure compliance.
- Internal floating roofs and seal to minimize vaporisation fuel storage tanks.
- Secondary containment is provided for all storage tanks for leaks in accordance with good engineering.

8.2.1.3. Impact Ratings

The operational phase activities will require similar mitigation measures to contains emissions from certain sources to the atmosphere, hence the rating of grouped some activities (Table 8-5) and separate for handling hazardous materials and diesel (Table 8-6).

Table 8-5: Significance Ratings for Establishment of Open Pit, Removal of Material, Stockpiling, Operation of the Plant, Construction of Surface Infrastructure

Activity and Interaction: Establishment of Open Pit, Removal of Material, Stockpiling, Operation of the Plant and Construction of Surface Infrastructure			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Dust generation and reduction in ambient air quality			
Prior to mitigation/ management			
Duration	Project life (5)	Dust will be generated for the project life	Major (negative) – 78
Extent	Local (3)	Airborne dust will extend across the development site area and beyond.	
Intensity	Very Serious (5)	Very serious impact on ambient air quality	
Probability	Almost certain (6)	It is almost certain that the impact will occur.	
Nature	Negative		
Mitigation/ Management actions			
• Application dust suppressant on the haul roads and exposed areas; • Limit activity to non-windy days (wind speed less than 5.4 m/s);			

Activity and Interaction: Establishment of Open Pit, Removal of Material, Stockpiling, Operation of the Plant and Construction of Surface Infrastructure			
Dimension	**Rating**	**Motivation**	**Significance**
• Set maximum speed limits on haul roads and have these limits enforced; • The area of disturbance must be kept to a minimum at all times and no unnecessary clearing, digging or scraping must occur, especially on windy days; and • The drop heights when loading onto trucks and at tipping points should be minimised.			
Post- mitigation			
Duration	Project life (5)	Dust will be generated for the project life	Negligible (negative) – 36
Extent	Limited (2)	Airborne dust will be limited to the project site and its immediate surrounding after mitigation.	
Intensity	Minor (2)	Minor impacts anticipated after mitigation	
Probability	Probable (4)	Probable that impact will occur after mitigation.	
Nature	Negative		

Table 8-6: Significance Ratings for Storage and Handling of Hazardous material (including Fuel and Explosives)

Activity and Interaction: Diesel Storage			
Impact Description: Release of Volatiles Resulting in Poor Air Quality			
Prior to mitigation/ management			
Duration	Project life (5)	Vapourisation and oil leaks from storage tanks will occur and explosive will be stored and used for the duration of the operational phase	Minor (negative) – 36
Extent	Limited (2)	Vapour and oil leaks released will be limited to the site and immediate surroundings	
Intensity	Minor (2)	Airborne vapour and oil leak will have a minor impact on ambient air quality during the operational phase	
Probability	Probable (4)	It is unlikely that released vapour and oil leaks will impact on ambient air quality.	
Nature	Negative		

<table>
<tr><th colspan="4">Mitigation/ Management actions</th></tr>
<tr><td colspan="4">Strict adherence to products and waste management plan;
Handled, stored, and disposed of hazardous substances in accordance with the local regulations;
Store hazardous substances in clearly labelled containers;
Deal with emergencies promptly i.e. spills; and
Provision of secondary containment for fuel storage.</td></tr>
<tr><th colspan="4">Post management</th></tr>
<tr><td>Duration</td><td>Project life (5)</td><td>Vapourisation and oil leaks from storage tanks will occur and explosive will be stored and used for the duration of the operational phase</td><td rowspan="5">Negligible (negative) – 21</td></tr>
<tr><td>Extent</td><td>Very Limited (1)</td><td>After mitigation measures are implemented, it is expected escape of vapour or leaks will be limited to isolated areas on site</td></tr>
<tr><td>Intensity</td><td>Minimal (1)</td><td>Minimal impact on ambient air quality after mitigation</td></tr>
<tr><td>Probability</td><td>Unlikely (3)</td><td>Probable that impact on ambient air quality will occur.</td></tr>
<tr><td>Nature</td><td>Negative</td><td></td></tr>
</table>

8.3. Decommissioning Phase

Activities during the Decommissioning Phase that may have potential impacts on the ambient air quality in the MRA and surroundings are indicated in Table 8-7.

Table 8-7: Interactions and Impacts of Activity

Interaction	Impact
Demolition and removal of infrastructure	Generation of dust Increased particulate matter load in the atmosphere leading to poor air quality Soiling of surfaces due to dustfall
Rehabilitation (spreading of the preserved subsoil and topsoil, profiling of the land and re-vegetation)	
Post-closure monitoring and rehabilitation	

8.3.1. Impact Description

The dismantling of mine infrastructure and rehabilitation activities which will include spreading of subsoil and topsoil, profiling, and re-vegetation of the MRA, will involve the use of heavy machinery and vehicles similar to those used in the construction phase. This will result in the release of fugitive emissions, such as TSP, PM_{10}, and $PM_{2.5}$. During this phase, hazardous products must be handled following operational protocol to avoid spills and evaporation from sources.

8.3.1.1. Management Objectives

The management objective is to ensure that emissions on-site and at 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.

8.3.1.2. Management Actions

- Particulate monitoring at upwind and downwind locations.
- Application of dust suppressants i.e. Dust-A-Side on haul roads and exposed areas to ensure compliance.
- Handled, stored, and disposed of hazardous substances in accordance with the local regulations.

8.3.1.3. Impact Ratings

The decommissioning phase activities will require similar mitigation measures to those employed during the construction phase. The impact rating for this phase is discussed in Table 8-8.

Table 8-8: Significance Ratings for Demolition and Removal of Infrastructure and Rehabilitation of the MRA

Activity and Interaction: Demolition and Removal of Infrastructure and Rehabilitation			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Dust generation and reduction in ambient air quality			
Prior to mitigation/ management			
Duration	Medium-term (3)	Dust will be generated in the medium term for the duration of each activity in the decommissioning phase	Major (negative) – 42
Extent	Limited (2)	Limited to the project area and immediate surroundings.	
Intensity	Minor (2)	Minor effect on surrounding air quality is anticipated	
Probability	Almost certain (6)	Almost certain that generated dust will impact ambient air quality.	
Nature	Negative		
Mitigation/ Management actions			
• Application dust suppressant on the haul roads and exposed areas; • Limit activity to non-windy days (wind speed less than 5.4 m/s); • Set maximum speed limits on haul roads and have these limits enforced; • The area of disturbance must be kept to a minimum at all times and no unnecessary clearing, digging or scraping must occur, especially on windy days; • The drop heights when loading onto trucks and at tipping points should be minimised; and • Proper rehabilitation of disturbed areas to allow for vegetation establishment.			
Post- mitigation			
Duration	Medium-term (3)	Dust will be generated in the medium term for the duration of each activity in the decommissioning phase	Negligible (negative) – 20
Extent	Very Limited (1)	After mitigation measures are implemented, It is expected that the dust generated will be limited to isolated parts of the site.	
Intensity	Minimal (1)	Generated dust will have minimal impacts on the ambient air quality after mitigation	
Probability	Probable (4)	Probable that impact on ambient air quality will occur.	

Activity and Interaction: Demolition and Removal of Infrastructure and Rehabilitation			
Dimension	**Rating**	**Motivation**	**Significance**
Nature	Negative		

8.4. Cumulative Impacts

Historical dustfall data for the MRA at sites Dalys2 and Dalys4, coupled with one month's record of daily PM_{10}, $PM_{2.5}$, SO_2 levels, and hourly NO_2 concentrations were used to evaluate cumulative impacts. For the dustfall, the averages over the 12 months at Dalys2 (277 mg/m^2/d) and Dalys4 (491 mg/m^2/d) were taken as the background to which the model predicted GLC for the same locations were added (**model prediction + the background**). For the fine particulates and gases, the 90th percentile values were chosen as the background for each of the pollutants. The values for pollutants were calculated at 3.5 µg/m^3 (PM_{10}), 2.3 µg/m^3 ($PM_{2.5}$), 3.4 µg/m^3 (SO_2), and (45 µg/m^3) for NO_2. The final cumulative values were then compared with the standards for compliance. The final cumulative concentrations for the different pollutants were below the limit values (Table 8-9). These values are summarised in Table 8-9 below.

Table 8-9: Comparison of Modelled to Baseline Data

Pollutants	Averaging Period	Location	Regulatory Limit	Dust Deposition Rates (mg/m^2/d)		
				Model	Background	Total
$PM_{2.5}$	24-hrs	SR1	40 µg/m^3	17	2.3	19.3
		SR2		1.5		3.8
PM_{10}	24-hrs	SR1	75 µg/m^3	145	3.5	149
		SR2		10		14
SO_2	24-hrs	SR1	125 µg/m^3	0.9	3.4	4.3
		SR2		0.3		3.7
NO_2	1-hr	SR1	200 µg/m^3	61	45	106
		SR2		43		88
Dust deposition	Monthly	Dalys2	600 mg/m^2/d	70	277	347
		Dalys4	1 200 mg/m^2/d	26	491	517

8.5. Unplanned and Low Risk Events

Table 8-10 highlights some likely unplanned events related to this Project. This was based on expert knowledge drawn from the related industry. Data on the type of incidents and frequency will assist in establishing the nature, risk type, geographic spread, and appropriate mitigation measures to curtail impacts in the event of an occurrence.

Table 8-10: Unplanned Events and Associated Mitigation Measures

Unplanned Risk	Mitigation Measures
Extreme wind erosion event	Adequate cover and care for storage facilities which will serve as protection during an unplanned event Exposed areas prone to erosions should be avoided or minimised at all times
Hydrocarbon spillage	Service mine machinery at designated service bays. Hydrocarbon spill kits must be available on-site at all locations where hydrocarbon spills could take place.
Fires	Robust Fire safety measures in place Fire outbreak alarm and extinguishing measures

9. Environmental Management Plan

Table 9-1 provides a summary of the proposed project activities, environmental aspects, and impacts on the receiving environment. Information on the mitigation measures, mitigation type, timing of implementation of the Environmental Management Plan (EMP) are specified.

Table 9-1: Environmental Management Plan

Activity	Potential Impacts	Aspects Affected	Phase	Mitigation Measures	Mitigation Type	Time period for implementation
• 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 the 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.	• Control through the implementation of an air quality management plan; • Dust control measures; and • Ambient air quality monitoring	On commencement of the construction phase and for the duration of the phase
• Diesel storage and explosives magazine	Airborne vapour will lead to poor air quality	Air Quality	Construction	• Strict adherence to products and waste management plan; • Handled, stored, and disposed of hazardous substances in accordance with the local regulations; • Store hazardous substances in clearly labelled containers; • Deal with emergencies promptly i.e. spills; and • Provision of secondary containment for fuel storage	• Hazardous substances management plan	On commencement of the construction phase and for the duration of the phase

Activity	Potential Impacts	Aspects Affected	Phase	Mitigation Measures	Mitigation Type	Time period for implementation
• Drilling and blasting of ROM ore and overburden • Operation of the open pit workings; • Loading, handling, and stockpiling of ROM ore and overburden • Storage, handling and treatment of hazardous material • Stockpiling (rock dumps, soils, ROM, discard dump) establishment and operation • Operation of the processing plant (including crushing and screening) • Operating sewage treatment plant • Storage, handling and treatment of hazardous products (including fuel, explosives, and oil) and waste	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 and haul roads; • Limit activity to non-windy days (with wind speed ≥ 5.4 m/s), if possible; • 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; • Set maximum speed limits and have these limits enforced; • Wet drilling • Handled, stored, and disposed of hazardous substances in accordance with the local regulations; • Store hazardous substances in clearly labelled containers; • Emergencies must be dealt with promptly i.e. spills; and • Provision of secondary containment for fuel storage	• Control through the implementation of an air quality management plan • Dust control measure • Ambient air quality monitoring • Hazardous substances management plan	Measurements must commence before the start of the operation phase and for the life of mine.
• Dismantling removal of infrastructure • Rehabilitation of MRA • Post-closure monitoring and rehabilitation	Reduction in the quality of ambient air due to the generation of dust	Air Quality	Decommissioning	• Apply wetting agents, dust suppressants, and binders on exposed areas; • Limit activity to non-windy days (with wind speed ≥ 5.4 m/s), if possible; • Keep the area of disturbance to a minimum and avoid any unnecessary clearing, digging, or scraping, especially on windy days; • Minimise the drop heights when loading onto trucks and at tipping points; • Set maximum speed limits and have these limits enforced; • The dismantling of infrastructure must occur in phases; • Limit demolition activities to non-windy days; • Rehabilitated landscape should be vegetated; and • Use of dust suppressant on dirt roads and exposed areas.	• Control through the implementation of an air quality management plan; • Dust control measure; and • Ambient air quality monitoring	On commencement of the decommissioning phase and for the duration of the phase

10. Monitoring Programme

It is recommended that the historic dust monitoring network be revived, and maintained from the construction phase through the LOM. In addition to the aforementioned, it is recommended that a continuous ambient monitoring station with the ability to measure both particulates and gases be commissioned before the commencement of construction phase activities. The frequency of monitoring will ensure that diurnal, seasonal, annual, and inter-annual records are available to inform management decision making. Table 10-1 shows the pollutants to be measured and the frequency of monitoring is depicted.

Table 10-1: Recommended Monitoring Plan

Method	Frequency	Target	Responsibility
Monitoring in accordance with the NEM:AQA (GN No. 27318 of 2004); NEM:AQA (GN No. 1210 of 2009); and National Dust Control Regulation (GN No. 827 of 2013)	• Monthly dustfall monitoring; • Continuous PM_{10}, $PM_{2.5}$ monitoring; • Continuous monitoring of gases: SO_2, NO_2, and CO	Particulate and gaseous pollutants from the Project must be below the South African standard: GN No. 827 of 2013; GN No. 1210 of 2009	A designated Environmental Officer (EO) to collect ambient air quality data and submit to an independent consultant for interpretation. The consultant will compile the reports for submission to the authorities

11. Stakeholder Engagement Comments Received

The comments received from stakeholders and the specialist response to these comments are tabulated in Table 11-1.

Table 11-1: Stakeholder Comments and Response

Category	Comment Raised	Contributor	Organisation / Community	Date	Method	Response
Air Quality	Ambient Air Quality Standards within the Waterberg District Municipality is affected	Vincent Raphunga (Air Quality Officer)	Waterberg District Municipality	01-Jul-20	Registration and Comment sheet	Emission of pollutants is inevitable. The Waterberg–Bojanala Priority Area (WBPA) was declared on 15 June 2012. As such, mitigation measures will be recommended to reduce emissions and subsequent impacts on ambient air quality. The approach adopted in this study was aligned with the requirements of the regulations. Existing ambient air quality was assessed, coupled with future implications associated with the operational phase.
Air Quality	All activities must be done according to Air Quality Acts and Regulations.					
Air Quality	Potential pollution	Alan Bosman	Eskom Holdings (Pty) Ltd	26-Jun-20	Registration and Comment sheet	Potential impacts associated with the operational phase have been assessed and reported and mitigation measures recommended.

12. Recommendations

Based on the results presented in this report, the following recommendations should be applied once operation commences:

- Revive the dustfall monitoring network and maintain for the LOM;
- Set up a continuous air quality monitoring station to measure criteria particulate and gaseous pollutants;
- Designate a qualified person to act as the EO to oversee implementation of mitigation measures and assess efficiency regularly;
- Ensure air quality information is incorporated into the environmental management information system and submit annual reports to the South African Atmospheric Emission Licensing & Inventory Portal (SAAELIP), as required by law;
- Establish codes of practice for good housekeeping concerning dust management and mitigation, including regular cleaning of spillages, spraying of stockpiles, open areas and roads, appropriate restrictions on vehicle movements and speeds;
- Housing of crushers and screens to contain emissions; and
- Monitor the air quality management measures and information to ensure that adopted mitigation measures are sufficient to achieve current air quality standards at the MRA boundary and the closest receptors.

13. Reasoned Opinion Whether Project Should Proceed

The proposed Dalyshope Coal Mine is within the Waterberg-Bojanala Priority Area (WBPA) declared a priority area on 15 June 2012 by the Minister of Water and Environmental Affairs (Government Notice 495 of 2012).

One of the main goals of the Limpopo Department of Economic Development, Environment and Tourism (LDEDET) highlighted in the WBPA Air Quality Management Plan (DEA, 2014) was to:

> *"Manage and control atmospheric emissions from major sources within the province to ensure compliance with emission limits and ambient air quality standards "*

Taking cognisance of the aforementioned, the proposed Project will be a major source, hence, will be subject to scrutiny by the authorities. As a result, the potential impacts from the proposed Project have been assessed and appropriate mitigation measures and management measures were identified to ensure compliance with standards. The air quality specialist will recommend the project proceeds, provided these measures are implemented because resulting emissions after mitigation will not exacerbate background pollutant levels beyond regulatory standards.

14. Conclusion

The AQIA was set out to establish the current air quality scenario in the proposed MRA and evaluate the future perturbation from the proposed Project operational phase and associated cumulative impacts. This assessment was limited to Block OC 1 and associated activities in an opencast mining operation. For this study, the approach adopted was to assess the worst-case scenario (i.e. without mitigation measures in place), which may have resulted in the model over-estimating the predicted impacts.

Findings from the baseline assessment have confirmed that the meteorology is influenced by dominant winds from the northeast and east-northeast respectively. The average wind speed was observed to be ~3.1 m/s, with winds greater than 5.4 m/s occurring for 7.3% of the time (with data showing records of wind speeds that ranged between 7.0 m/s to 11.0 m/s). Therefore, an unplanned event of a sudden wind gust sweeping through the proposed MRA is possible.

For dustfall (particulate matter with an aerodynamic diameter less than 45 µm (considered as Total Suspended Particulate (TSP)), data from 12 months of monitoring at eight sites were used to evaluate the background scenario. Measured dustfall rates were below the residential and non-residential limits for most of the sites, except for those in the vicinity of a cattle feedlot. The results show that the 90th percentile of the dustfall data measured was below 588 mg/m^2/d. For the fine particulate matter, data from a quality continuous monitor (AQ-Mesh) was used to confirm the current status quo. The highest ambient concentration of particulate matter with an aerodynamic diameter of less than 10 microns and 2.5 microns i.e. PM_{10} and $PM_{2.5}$ measured were below 5 µg/m^3. These maximums for PM_{10} and $PM_{2.5}$ were at 6% and 8% of the respective regulatory limits. For the gaseous pollutants, the highest values measured for sulfur dioxide (SO_2), nitrogen dioxide (NO_2), and carbon dioxide (CO) were at 4%, 38%, and 1% of their respective regulatory limit values.

Predicted emissions anticipated from the operational phase of the Project was assessed using a conceptual model. Model simulations of GLC of criteria pollutants were generated using the American Meteorological Society and the United States Environmental Protection Agency (USEPA) Regulatory Model (AERMOD). Isopleths were generated for different averaging periods as recommended by the regulatory authorities and compared with the South African standards to ascertain compliance.

A summary of the predicted GLC is given below:

- The predicted 24-hr $PM_{2.5}$ GLC shows that there will be exceedances of the South African standard of 40 µg/m. These exceedances will be largely confined to the MRA. The GLC predicted for the nearby sensitive receptor locations SR 1 and SR 2 were below the daily limit. The predicted annual GLC of $PM_{2.5}$ were below the South African standard of 20 µg/m^3. With mitigation measures in place, the area with exceedance within the MRA can be reduced, while ensuring compliance with the standard at the boundary.

- The predicted 24-hr GLC of PM_{10} confirmed that exceedances of the South African standard of 75 µg/m³ will occur. Although the area with exceedances will be mostly confined to within the MRA, adjacent areas some 1 km east, north, and west outside the MRA will be affected. The annual PM_{10} GLC showed that the predicted exceedances will be confined within the MRA. As a result, the GLC at the nearby sensitive receptors were below the South African standard of 40 µg/m³.
- The predicted dustfall rates show that exceedances of the non-residential limit of 1,200 mg/m^2/d will occur within the MRA and adjacent areas in the southwest direction (downwind). The predicted dustfall rates at the selected sensitive receptors were below the residential limit of 600 mg/m^2/d and non-residential limit.
- The predicted NO_2 1-hr GLC shows that exceedance of the South African standard of 200 µg/m^3 will be experienced within the MRA and areas adjacent to the southwestern boundary. The predicted levels will be lower than the reported if mitigation measures are implemented. The GLC at the nearby receptors were lower than the standard.
- The predicted SO_2 24-hr GLC shows that exceedance of the South African standard of 125 µg/m^3 is not likely to occur during the operational phase. The isopleth shows that the area with elevated emissions will be confined within the MRA, with negligible implications on surrounding sensitive receptors.

The cumulative impacts were assessed by a combination of the model prediction and the background levels confirmed that the final concentrations will be within regulatory limit values at some receptor locations.

The impacts of the proposed Project were evaluated using a risk matrix that considers the nature, significance, extent, duration, and probability of impacts occurring. Based on this rating system, impacts on the surrounding receptors from the operational phase are deemed “major negative” without mitigation. However, with mitigation, the impacts were reduced to “negligible negative”. Since anticipated emissions from the operational phase activities are likely to influence receptors outside the MRA boundary, mitigation and management interventions are crucial.

Some of the possible mitigation measures and management intervention recommended include:

- Application of dust suppressants/binders on haul roads and exposed areas, setting maximum speed limits on haul roads and to have these limits enforced, rehabilitation of stockpiles to prevent wind erosion (considering that haul roads and wind erosion from storage facilities are amongst the highest emissions sources), and enclosure of crushers;
- Operation of ambient air quality monitoring network for particulates and gases to provide valuable data needed to assess the effectiveness of mitigation measures in place; and
- Relocation of receptor location within a 2.0 km radius.

Once the mine implements the recommended mitigation measures outlined in this report, associated emissions can be contained to below standards, ensuring compliance with regulatory requirements.

15. References

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Appendix A: 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 15-1. 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 15-2, which is extracted from Table 15-1. The description of the significance ratings is discussed in Table 15-3.

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 15-1: 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 15-2: Probability/Consequence Matrix

Significance

Probability																																						
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 15-3: 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)