APPENDIX H: SPECIALIST STUDIES
AIR QUALITY

A Basic Air Quality Assessment for the Proposed New Vents at Marula Platinum Mine in Limpopo

Project done on behalf of **SLR Consulting (Africa) (Pty) Ltd**

Report Compiled by:
Gillian Petzer

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Report Details

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Report Title	A Basic Air Quality Assessment for the Proposed New Vents at Marula Platinum Mine in Limpopo
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Project Consultant	SLR Consulting (Africa) (Pty) Ltd
Prepared by	Gillian Petzer, Pr Eng, (BEng, Chemical, Univ. of Pretoria)
Reviewed by	Reneé von Gruenewaldt, Pr. Sci Nat, (MSc, Univ. of Pretoria)
Notice	Airshed Planning Professionals (Pty) Ltd is a consulting company located in Midrand, South Africa, specialising in all aspects of air quality, ranging from nearby neighbourhood concerns to regional air pollution impacts as well as noise impact assessments. The company originated in 1990 as Environmental Management Services, which amalgamated with its sister company, Matrix Environmental Consultants, in 2003.
Declaration	I, Gillian Petzer, as authorised representative of Airshed Planning Professionals (Pty) Ltd hereby confirm my independence as a specialist and declare that neither I nor Airshed Planning Professionals (Pty) Ltd have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of which Airshed Planning Professionals (Pty) Ltd was appointed as air quality specialists in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998); other than fair remuneration for worked performed, specifically in connection with the assessment summarised in this report. I also declare that I have expertise in undertaking the specialist work as required, possessing working knowledge of the acts, regulations and guidelines relating to the application. I further declare that I am able to perform the work relating to the application in an objective manner, even if this result in views and findings that is not favourable to the application; and that I am confident in the results of the studies undertaken and conclusions drawn as a result of it – as is described in this report.
Copyright Warning	

Revision Record

Revision Number	Date	Reason for Revision
0	August 2020	Report for review
1	August 2020	SLR impact assessment methodology
1.1	November 2020	Incorporation of clients comments

Specialist Report Requirements (NEMA Regulation, 2017)

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	Relevant section in report
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;	Report details (page ii) Section 7 (Appendix C)
b	a declaration that the specialist is independent in a form as may be specified by the competent authority;	Report details (page ii) Section 7 (Appendix B)
c	an indication of the scope of, and the purpose for which, the report was prepared;	Section 1.1
cA	an indication of the quality and age of base data used for the specialist report;	Section 3
cB	a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 3
d	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 3.2
e	a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Sections 1.2 and 4.1
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 3.1
g	an identification of any areas to be avoided, including buffers;	NA
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;	NA
i	a description of any assumptions made and any uncertainties or gaps in knowledge;	Sections 1.4
j	a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment or activities;	Sections 4.3, 5
k	any mitigation measures for inclusion in the EMPr;	NA
l	any conditions for inclusion in the environmental authorisation;	Section 5
m	any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section 5
n	a reasoned opinion- (i) as to whether the proposed activity, activities or portions thereof should be authorised; (iA) regarding the acceptability of the proposed activity or activities; and (ii) 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;	Section 5
o	a description of any consultation process that was undertaken during the course of preparing the specialist report;	NA
p	a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	NA
q	any other information requested by the competent authority.	NA

Abbreviations

Airshed	Airshed Planning Professionals (Pty) Ltd
AQSR	Air Quality Sensitive Receptor
ASTM	American Society for Testing and Materials
DEA	Department of Environmental Affairs (South Africa)
DEFF	Department of Environment, Forestry and Fisheries (previously DEA)
DPM	Diesel particulate matter
GLC(s)	Ground level concentration(s)
IFC	International Finance Corporation
NAAQS	National Ambient Air Quality Standards (South Africa)
NDCR	National Dust Control Regulations
NEM:AQA	National Environmental Management Air Quality Act (South Africa)
SA	South Africa(n)
TSP	Total suspended particulate matter
US EPA	United States Environmental Protection Agency

Symbols and Units

°C	Degrees Celsius
µg	Microgram(s)
µg/m³	Micrograms per cubic meter
m/s	Metres per second
m²	Metres squared
mg	Milligram(s)
PM	Particulate Matter
PM_{10}	Thoracic particulate matter
$PM_{2.5}$	Respirable particulate matter
tpa	Tonnes per annum

Executive Summary

Introduction

SLR Consulting (Africa) (Pty) Ltd (SLR) appointed Airshed Planning Professionals (Pty) Ltd (Airshed) to do a basic air quality assessment. It is understood that the Marula Platinum Mine in Limpopo is proposing to develop two new vent shafts, both of which will have aboveground fans. There will also be three shafts which will have additional infrastructure of bulk air coolers and refrigeration plants.

Scope and Approach

The purpose of this investigation was to determine baseline air quality conditions, identify sensitive receptors and quantify and assess the potential impact that the proposed new vents may have on the receiving environment.

The following tasks, typical of a basic air quality impact assessment, were included in the scope of work:

- A review of surrounding activities in order to identify sources of emission and associated pollutants;
- A study of regulatory requirements for identified key pollutants against which compliance need to be assessed;
- A study of the environment in the vicinity of the proposed development; including:
    - The identification of potential air quality sensitive receptors (AQSRs); and
    - The analysis of all available ambient air quality information/data to determine pre-development ambient pollutant levels and dustfall rates.
- The compilation of an emissions inventory;
- Atmospheric dispersion modelling, using a Tier 1 model, to simulate ambient air pollutant concentrations;
- A screening assessment to determine the potential compliance of simulated criteria pollutant concentrations with ambient air quality standards.
- The compilation of a basic air quality report detailing the study approach, limitations, assumption, results and recommendations.

Management of Uncertainties

The main assumptions and limitations from the basic air quality impact assessment are:

- The underground shafts will need to be compliant with occupational exposure limits (OEL). These limits were used in the dispersion modelling exercise as a conservative estimate of the incremental impact of proposed vents.
- No ambient criteria pollutant data was available close to site. It was therefore only possible to estimate the incremental impact from the vents only.

Main Findings and Recommendation

The main findings from the basic air quality impact assessment are:

- Historic dust fallout data at the mine indicates compliance with the National Dust Control Regulations (NDCR). The dust fallout from the vents were not assessed as only Tier 1 modelling was undertaken[1]. The proposed vents, however, will not result in significant dust fallout.
- Simulated ambient criteria pollutant (PM_{10} (particulate matter 10 micrometers or less in diameter) and $PM_{2.5}$ (particulate matter 2.5 micrometers or less in diameter)) concentrations were below the National Ambient Air Quality Standards (NAAQS) at all the nearby air quality sensitive receptors.

It is recommended that the mine continues with the dust fallout monitoring.

In conclusion, it is the specialist opinion that the proposed new ventilation shafts may be authorised.

[1] Tier 1 models are only able to simulate highest hourly ground level concentrations.

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A Basic Air Quality Assessment for the Proposed new Vents at Marula Platinum Mine in Limpopo

1 INTRODUCTION

SLR Consulting (Africa) (Pty) Ltd (SLR) appointed Airshed Planning Professionals (Pty) Ltd (Airshed) to undertake a basic air quality assessment. It is understood that the Marula Platinum Mine in Limpopo is proposing to develop two new vent shafts, both of which will have aboveground fans. There will also be three shafts which will have additional infrastructure of bulk air coolers and refrigeration plants (Table 1).

Table 1: Summary of Marula vents

Shaft	EMPr Status	Additional requirements that need approval
Driekop shaft complex		
V#6	Existing and approved shaft	Requires a new bulk air cooler, refrigeration plant and condenser cooling towers.
V#9	New shaft	New vent shaft with surface main fans and electrical rooms.
Clapham shaft complex		
V#5	Existing and approved shaft	Requires a new Bulk Air Cooler.
V#7	Approved shaft but not yet established	Authorisation is needed for surface main fans, electrical rooms, refrigeration plant and condenser cooling towers.
V#8	New shaft	Authorisation is needed for the new vent shaft with bulk air cooler.

The proposed location of the vents can be seen in Figure 1.

1.1 Scope of Work

The purpose of this investigation is to determine baseline air quality conditions, identify sensitive receptors and quantify and assess the potential impact that the proposed vents may have on the receiving environment.

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

- A review of surrounding activities in order to identify sources of emission and associated pollutants;
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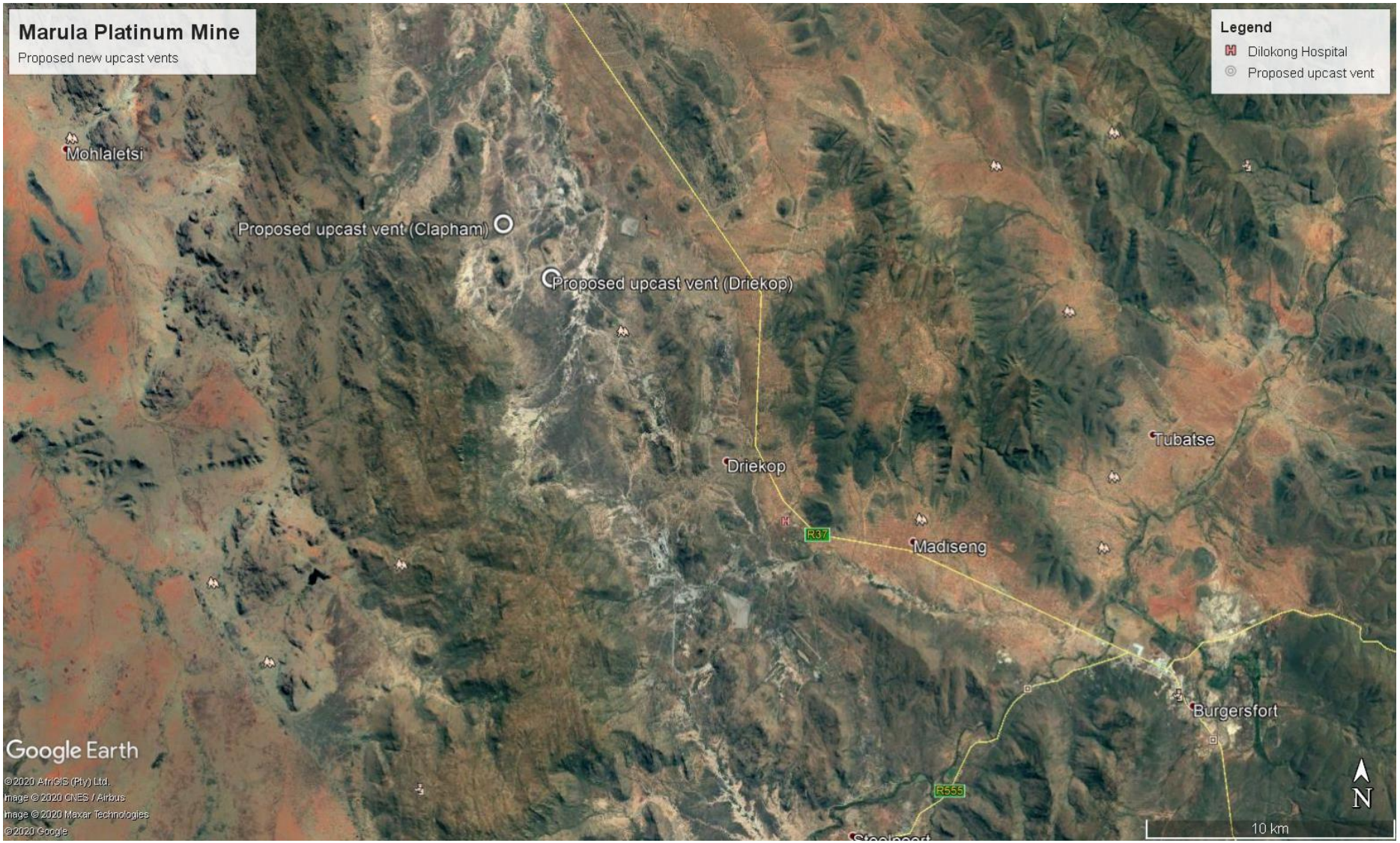

Figure 1: Locality map showing the proposed vents

1.2 Specialist Details

1.2.1 Specialist Details

Airshed is an independent consulting firm with no interest in the project other than to fulfil the contract between the client and the consultant for delivery of specialised services as stipulated in the terms of reference. A Declaration of Independence is provided in Appendix B.

1.2.2 Competency Profile of Specialist

Gillian Petzer holds a bachelor's degree in chemical engineering from the University of Pretoria. She is a registered professional engineer. Her experience in air quality started in 2000 with the "Indoor Air Quality" division of Building Research Establishment (BRE) in the UK. She started with air quality impact assessments at Airshed in 2003. She has been involved in several EIA projects and has conducted specialist studies for air pollution impact components of EIAs. Over the last decade Gillian Petzer has been actively involved in the development of atmospheric dispersion modelling and its applications, air pollution compliance assessments, health risk assessments, mitigation measures, development of air quality management plans, as well as meteorological and air quality monitoring programmes. Whilst most of her working experience has been in South Africa, a number of investigations were made in countries elsewhere, including Botswana, Equatorial Guinea, Eritrea, Ghana, Guinea, Kenya, Mauritania, Mozambique, Namibia and Nigeria.

A comprehensive curriculum vitae of Gillian Petzer is provided in Appendix C.

1.3 Approach and Methodology

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

1.3.1 Project Information and Activity Review

All project related information referred to in this study was provided by SLR or the engineers designing the vents (Bluhm Burton Engineering Pty Ltd (BBE)).

1.3.2 The Identification of Regulatory Requirements and Screening Criteria

In the evaluation of ambient air quality impacts reference was made to the South African National Ambient Air Quality Standards (NAAQS) for criteria pollutants.

1.3.3 Determining the Impact of the Project on the Receiving Environment

The establishment of an emission inventory formed the basis for the assessment of the air quality impacts of the proposed vents on the receiving environment.

1.3.4 Compliance Assessment

Compliance was assessed by comparing simulated ambient particulate matter concentrations to selected ambient air quality criteria.

1.3.5 Impact Significance

The significance of air quality impacts was assessed according to the methodology provided by SLR Consulting (South Africa) (Pty) Ltd. Refer to Appendix A of this report for the methodology.

1.4 Management of Uncertainties

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

- Constructional phase impacts of the proposed site were not quantified. These impacts are expected to be of short duration.
- Emissions from the vents for the operational phase were conservatively assumed to be equal to the occupational exposure limits (OELs).
- A level 1 screening assessment was done as a level 1 assessment provides an estimate of the worst-case air quality impacts. Tier 1 screening models are sufficient for this level of assessment.

2 REGULATORY REQUIREMENTS AND IMPACT ASSESSMENT CRITERIA

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

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

2.1 Ambient Air Quality Standards for Criteria Pollutants

Criteria pollutants are considered those pollutants most commonly found in the atmosphere, that have proven detrimental health effects when inhaled and are regulated by ambient air quality criteria. In the context of this project, these include particulate matter (PM). Mining projects main pollutant of concern is PM. Although other pollutants may be emitted, they are not considered significant.

National Ambient Air Quality Standards (NAAQS) were determined based on international best practice for PM_{10}, $PM_{2.5}$, dustfall, SO_2 (sulphur dioxide), NO_2 (nitrogen dioxide), CO (carbon monoxide), ozone (O_3), lead (Pb) and benzene (C_6H_6). The final revised NAAQSs were published in the Government Gazette on 24 of December 2009 (Government Gazette, 2009) and included a margin of tolerance (i.e. frequency of exceedance) and implementation timelines linked to it. NAAQS for $PM_{2.5}$ were published on 29 July 2012 (Government Gazette, 2012). The NAAQSs referred to in this study are listed in Table 2.

Table 2: Air quality standards for criteria pollutants (SA NAAQS)

Pollutant	Averaging Period	Concentration (µg/m³)	Frequency of Exceedance (FOE)	Compliance Date
$PM_{2.5}$	24 hour	40	4	Currently enforceable
	1 year	20	-	
	24 hour	25	4	1 January 2030
	1 year	15	-	
PM_{10}	24 hour	75	4	Currently enforceable
	1 year	40	-	

2.2 National Dust Control Regulations

The National Dust Control Regulations (NDCR) were published on the 1st of November 2013 (Goverment Gazette, 2013). The purpose of the regulation is to prescribe general measures for the control of dust in all areas including residential and non-residential areas. Acceptable dustfall rates according to the regulation are summarised in Table 3.

Table 3: Acceptable dustfall rates

Restriction areas	Dustfall rate (D) in mg/m²-day over a 30 day average	Permitted frequency of exceedance
Residential areas	D < 600	Two within a year, not sequential months.

Non-residential areas	600 < D < 1 200	Two within a year, not sequential months.

The regulation also specifies that the method to be used for measuring dustfall and the guideline for locating sampling points shall be ASTM D1739 (1970), or equivalent method approved by any internationally recognized body. It is important to note that dustfall is assessed for nuisance impact and not inhalation health impacts. It should be noted that the requirements of the regulations only become applicable to a specific installation or site after a written notice has been given to the site/installation by the local Air Quality Officer.

2.3 Regulations Regarding Air Dispersion Modelling

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

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

The Regulation has been applied to the development of this report. The first step in the dispersion modelling exercise requires a clear objective of the modelling exercise and thereby gives clear direction to the choice of the dispersion model most suited for the purpose. Chapter 2 of the Regulations present the typical levels of assessments, technical summaries of the prescribed models (SCREEN3, AERSCREEN, AERMOD, SCIPUFF, and CALPUFF) and good practice steps to be taken for modelling applications. The proposed operation falls under a Level 1 assessment which is described as follows;

- Licence / approval decisions for typically single sources.
- Preliminary identification of air quality issues associated with proposed new sources or modifications to existing sources.
- Identification of the need for more detailed modelling using Level 2 or 3 assessment approaches (if exceedances of short-term objectives are predicted) and;
- Confirmation of refined model results that might appear unusually high or low.

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

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

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

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

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

3 DESCRIPTION OF THE RECEIVING ENVIRONMENT

3.1 Air Quality Sensitive Receptors

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

The nearest residential areas to the proposed Driekop vent (elevation 907 m) are Galane and Diphale. The AQSRs are illustrated in Table 4 and Figure 2. AQSRS were selected based on the closest receptors to the vents in various wind directions, as well as AQSRs located at elevations higher than the vent stack height (complex terrain).

Table 4: AQSRs near the Proposed Driekop Vent

Number	Elevation (m)	Distance from vent (m)
1	905	440
2	904	460
3	612	465
4	914	420
5	920	450
6	913	390
7	926	810
8	924	670
9	916	670
10	926	820

The nearest residential areas to the proposed Clapham vent (elevation 902 m) are Winnaarshoek and Diphale. The AQSRs are illustrated in Table 5 and Figure 3.

Table 5: AQSRs near the Proposed Clapham Vent

Number	Elevation (m)	Distance from vent (m)
1	898	340
2	904	470
3	905	750
4	908	850
5	911	710
6	911	520
7	932	840
8	928	1 000
9	926	1 000
10	893	640

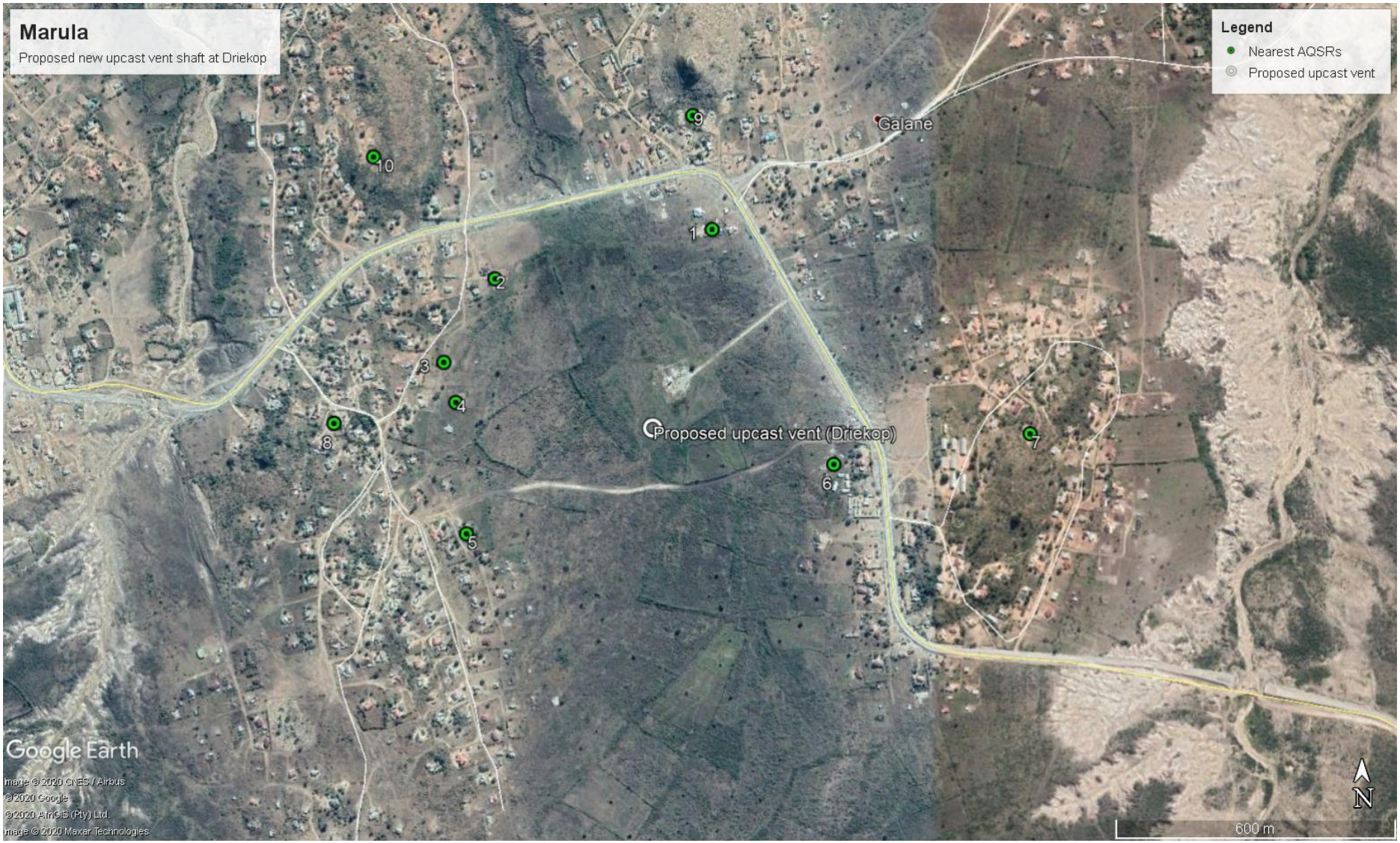

Figure 2: AQSRs Surrounding the Proposed Driekop Vent

Figure 3: AQSRs Surrounding the Proposed Clapham Vent

3.2 Site Visit

A site visit was not conducted by Airshed for the air quality impact assessment, however adequate project information was obtained from SLR for the air quality impact assessment.

3.3 Ambient Air Quality within the region

3.3.1 Sources of Air Pollution within the Region

Various platinum mining activities, farming and residential land-uses occur in the vicinity of the proposed development area. These land-use activities contribute to baseline pollutant concentrations via vehicle tailpipe emissions, household fuel combustion, biomass burning and various fugitive dust sources. Long-range transport of particulates, emitted from remote tall stacks and from large-scale biomass burning in countries to the north of South Africa, has been found to contribute significantly to background fine particulate concentrations within the South African boundary (Andreae, et al., 1996; Garstang, et al., 1996; Piketh, et al., 1996).

Sources of atmospheric emissions include:

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

From the 2012 study done by Airshed Planning Professionals (Pty) Ltd. for the Marula Mine (Liebenberg Enslin & Gresse, 2012), PM_{10} emissions were estimated to be 34 tpa.

3.3.2 Measured Ambient Air Quality

Historic dust fallout data was obtained from the 2012 Airshed report done for the Marula Mine (Liebenberg Enslin & Gresse, 2012). No more recent data was available. The nearest site to the proposed vents (the “Raw Water Dam” measuring a maximum of 375 mg/m²/day (Aug 2010), ~2.9 km north-northwest from the Driekop Vent and ~1.25 km northeast from the Clapham Vent) was compliant with the NDCR for residential areas.

4 IMPACT ON THE RECEIVING ENVIRONMENT

4.1 Atmospheric Emissions

A discussion on the expected activities is provided in the sections below.

4.1.1 Construction Phase

Construction operations are potentially significant sources of dust emissions that may have a substantial temporary impact on local air quality. Construction air emissions would result from general site preparation for the developments. Construction activities that contribute to air pollution typically include: land clearing and demolition activities, excavation, material handling activities, wheel entrainment, operation of diesel or petrol engines etc. If not properly mitigated, construction sites could generate high levels of dust (typically from concrete, cement, wood, stone, silica) and this has the potential to travel for large distances.

Construction dust may be grouped into total suspended particulate matter (TSP) with impacts generally close to the construction activities and are more responsible for soiling than health issues. Health impacts are more associated with the finer PM_{10} and $PM_{2.5}$ fractions, both of which are invisible to the naked eye. Research has shown that PM_{10} and even more significantly $PM_{2.5}$ penetrate deeply into the lungs and therefore has the potential to cause a wide range of health problems including respiratory illness, asthma, bronchitis and even cancer.

Combustion engines also emit emissions of CO, HC, NOx and CO_2. A potentially source of $PM_{2.5}$ on construction sites comes from the diesel engine exhausts of on- and off-road utility vehicles and heavy equipment as well as stationary combustion sources. These particles are known as diesel particulate matter (DPM), and consist of soot (unburnt organic material), sulfates and silicates, all of which may readily combine with other compounds in the atmosphere, increasing the health risks of particle inhalation. Other noxious vapours may also originate from oils, glues, thinners, paints, treated woods, plastics, cleaners and other hazardous chemicals that may be used on construction sites.

A significant amount of the dust emissions result from construction vehicle traffic over temporary roads at construction sites. Dust emissions can also vary substantially from day to day, depending on the level of activity, the specific operations, and the prevailing meteorological conditions.

Air quality impacts will be associated with the construction phase of the proposed vents and additional infrastructure; however, this will be of a short duration.

4.1.2 Operational Phase

The establishment of an emission inventory formed the basis for the assessment of the air quality impacts from the proposed vents on the receiving environment.

Source parameters and emission rates are included in Table 6 and Table 7. It has conservatively been assumed that the vents are operational 24 hours per day, 7 days per week.

Table 6: Point Source Parameters per vent discharge point

Source Name	Latitude (decimal degrees)	Longitude (decimal degrees)	Height of Release Above Ground (m)	Diameter at Stack Tip / Vent Exit (m)	Actual Gas Exit Temperature (°C)	Actual Gas Volumetric Flow (m^3/hr)	Actual Gas Exit Velocity (m/s)
Driekop new vent	-24.530	30.078	10	3.66	30	529 200	14
Clapham new vent	-24.511	30.058	10	3.66	30	642 600	17

Table 7: Point Source Emissions per vent discharge point

Source Name	Pollutant Name	OEL (mg/m^3)	Emission rate (g/s)
Driekop new vent	PM_{10}	10	1.32
	$PM_{2.5}$	3	0.40
Clapham new vent	PM_{10}	10	1.61
	$PM_{2.5}$	3	0.48

OELs were conservatively used to estimate emissions from the vents as the mine would have to comply with the occupational limits underground. A summary of emissions is shown in Table 8.

Table 8: Stack emissions summary

Source Name	Pollutant Name	Per Vent	Number Vents at Shaft	Total (g/s)	Total (tpa)
Driekop new vent shaft	PM_{10}	1.32	2	2.65	84
	$PM_{2.5}$	0.40	2	0.79	25
Clapham new vent shaft	PM_{10}	1.61	3	4.83	152
	$PM_{2.5}$	0.48	3	1.45	46

4.2 Atmospheric Dispersion Modelling

The impact of the proposed vents on the atmospheric environment was determined through the simulation of ambient pollutant concentrations.

Dispersion models simulate ambient pollutant concentrations and dustfall rates as a function of source configurations, emission strengths and meteorological characteristics, thus providing a useful tool to ascertain the spatial and temporal patterns in the ground level concentrations arising from the emissions of various sources. Increasing reliance has been placed on concentration estimates from models as the primary basis for environmental and health impact assessments, risk assessments and emission control requirements. It is therefore important to carefully select a dispersion model for this purpose.

South African Regulations Regarding Air Dispersion Modelling provides guidance on the use of a tiered approach in defining the levels of assessment required in a modelling application. This Code of Practice also recommends a number of dispersion models to be used in regulatory applications in South Africa. This requires a modeller to assess the application and identify which model would best provide the essential information to the regulatory authority with the detail and accuracy required in

the application. Air quality assessments can vary in their level of detail and scope, which in turn is determined by the objectives of the modelling effort, technical factors and the level of risk associated with the project emissions.

A classical tiered approach in the selection of an air dispersion model is recommended, in which simpler screening models (Level 1) are first considered before moving to more advanced models if the situation requires (Level 2 or 3). The screening techniques must be used on relatively simple applications to provide conservative estimates of air quality impact using (pre-set) worst-case meteorological conditions. Otherwise, refined models must be applied where detailed treatment of physical and chemical atmospheric processes are required. The tiered approach minimises the cost and time required to do an assessment or licence application. It allows for flexibility in selecting a model that is most appropriate for a given application based on the assessment. Where a preliminary/conservative estimate is desired, acceptable screening techniques must be used, followed by the appropriate refined analysis.

The level of assessment must depend on the technical factors to be considered in the modelling exercise such as the geophysical, emissions and meteorological conditions. The assessment must also depend on the level of risk associated with the emissions and hence the level of detail and accuracy required from a model.

Given the low level of emissions, a Level 1 modelling approach was conducted.

4.2.1 Dispersion Model Selection

A level 1 assessment provides an estimate of the worst-case air quality impacts. As such, screening models are sufficient for this level. Level 1 assessment must be used for:

- License / approval decisions for typically single sources, as is the case for the proposed vents.
- Preliminary identification of air quality issues associated with proposed new sources or modifications to existing sources.
- Identification of the need for more detailed modelling using Level 2 or 3 assessment approaches (if exceedances of short-term objectives are predicted) and;
- Confirmation of refined model results that might appear unusually high or low.

As recommended by the Code of Practice, use was made of SCREEN3, a tool to calculate screening-level impact estimates for stationary sources in simple terrain or complex terrain.

SCREEN3 is a Gaussian plume model which provides maximum ground-level concentrations for point, area, flare, and volume sources. The model is a single source model and impacts from multiple SCREEN3 model runs can be summed to conservatively estimate the impact from several sources. SCREEN3 calculates 1-hour concentration estimates in simple terrain areas and 24-hour concentration estimates in complex terrain. These modelled estimates must be converted to the averaging period of each applicable national ambient air quality standard. The factor to convert from 1-hour to 1-day is 0.4, and from 1-hour to 1-year is 0.08.

SCREEN3 incorporates source related factors and meteorological factors to estimate pollutant concentration from continuous sources. The model assumed that the pollutant does not undergo any chemical reactions, and that no other removal processes (wet or dry deposition) act on the plume during its transportation. SCREEN3 examines a range of stability classes and wind speeds to identify the combination of wind speed and stability that results in the maximum ground level concentrations – the "worst case" meteorological conditions. Use was made of the stack tip downwash estimation following the Briggs equations.

Dispersion coefficients are estimated from the Pasquill-Gifford (rural) and McElroy-Pooler (urban) methods based on the Industrial Source Complex (ISC3) formulations. The dispersion coefficients are adjusted to account for the effects of buoyancy induced dispersion. For this assessment, use was made of the rural dispersion coefficients.

4.2.2 Meteorological Requirements

Use was made of (pre-set) worst-case meteorological conditions.

4.2.3 Source and Emission Data Requirements

The SCREEN model is able to model point, area, line and volume sources. The proposed ventilation shafts were modelled as point sources.

4.2.4 Modelling Domain

The dispersion of pollutants was simulated at various receptor points. SCREEN3 calculates ground-level (1.5 m above ground level) concentrations at each receptor point.

Both the simple and the complex terrain was selected. The complex terrain option is used for cases where the terrain elevations exceed the stack height.

4.2.5 Presentation of Results

Simulations were undertaken to determine highest hourly pollutant concentrations. Highest daily and annual average ground level concentrations were extrapolated through the application of factors specified in the Code of Practice. Averaging periods were selected to facilitate the comparison of predicted pollutant concentrations to relevant NAAQS and screening criteria.

Results are presented in tabular form as maximum ground level pollutant concentrations in comparison with assessment criteria.

4.3 Dispersion Simulation Results

Pollutants released by the proposed operations, likely to result in human health impacts include the following criteria pollutants: PM_{10} and $PM_{2.5}$.

Ground level pollutant concentrations at the selected sensitive receptors (are summarised in Table 9 and Table 10). Simulated worst-case concentrations are well within NAAQS both in the short and long term at all selected AQSRs.

Given the conservative nature of the impact assessment, it can be concluded that emissions from the proposed vents will not result in exceedances of NAAQS at the closest sensitive receptors.

Table 9: Simulated ground level concentrations at the nearest AQSRs (Driekop)

AQSR	PM_{10} daily concentration (µg/m³)	PM_{10} annual concentration (µg/m³)	$PM_{2.5}$ daily concentration (µg/m³)	$PM_{2.5}$ annual concentration (µg/m³)
1	25	5.0	8	1.5
2	24	4.8	7	1.4
3	30	6.0	9	1.8
4	37	7.4	11	2.2
5	38	7.7	12	2.3
6	39	7.8	12	2.4
7	21	4.2	6	1.3
8	25	5.1	8	1.5
9	24	4.9	7	1.5
10	21	4.2	6	1.3
NAAQS	**75**	**40**	**40**	**20**

Table 10: Simulated ground level concentrations at the nearest AQSRs (Clapham)

AQSR	PM_{10} daily concentration (µg/m³)	PM_{10} annual concentration (µg/m³)	$PM_{2.5}$ daily concentration (µg/m³)	$PM_{2.5}$ annual concentration (µg/m³)
1	49	9.8	15	2.9
2	40	8.0	12	2.4
3	28	5.5	8	1.6
4	28	5.6	8	1.7
5	37	7.4	11	2.2
6	49	9.7	14	2.9
7	32	6.4	10	1.9
8	28	5.5	8	1.6
9	28	5.5	8	1.6
10	27	5.4	8	1.6
NAAQS	**75**	**40**	**40**	**20**

4.4 Impact Significance Rating

EIA Regulations require that impacts be assessed in terms of the intensity, duration, severity and probability of impacts; as well as the degree to which these impacts can be managed or mitigated. A significance ranking methodology is provided in Appendix B.

The impact significance rating for potential impacts are presented in Table 11. All potential impacts were assigned impact rating scores equivalent to "**low"** impact significance. It is possible that the proposed vents will have an impact. The duration will last for the lifespan of the mine.

Table 11: Impact significance rating table

Source	IMPACT DESCRIPTION		RATING					
	Impact	Associated activities	Intensity	Duration	Extent	Consequence	Probability	Significance
Impacts due to proposed vents	Health impacts due to emissions	PM emissions from vent shaft	Low	Long term	Medium	Medium	Possible	Low

5 CONCLUSIONS AND RECOMMENDATION

An air quality impact assessment was conducted for the impact of the proposed vents on the receiving environment.

The main findings from the air quality impact assessment are:

- Historic dust fallout data at the mine indicates compliance with the NDCR. The dust fallout from the vents were not assessed as only Tier 1 modelling was undertaken[2]. The proposed vents, however, will not result in significant dust fallout.
- Simulated ambient criteria pollutant (PM_{10} and $PM_{2.5}$) concentrations were below the National Ambient Air Quality Standards (NAAQS) at all the nearby air quality sensitive receptors.

It is recommended that the mine continues with the dust fallout monitoring.

In conclusion, it is the specialist opinion that the proposed new ventilation shafts may be authorised.

[2] Tier 1 models are only able to simulate highest hourly ground level concentrations.

6 REFERENCES

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7 APPENDIX

7.1 Appendix A - Impact Assessment Methodology

The methodology used for assessing the significance of the impact was obtained from the SLR.

PART A: DEFINITIONS AND CRITERIA		
Definition of SIGNIFICANCE		**Significance = consequence x probability**
Definition of CONSEQUENCE		**Consequence is a function of intensity, spatial extent and duration**
Criteria for ranking of the INTENSITY of environmental impacts	**VH**	Severe change, disturbance or degradation. Associated with severe consequences. May result in severe illness, injury or death. Targets, limits and thresholds of concern continually exceeded. Substantial intervention will be required. Vigorous/widespread community mobilization against project can be expected. May result in legal action if impact occurs.
	H	Prominent change, disturbance or degradation. Associated with real and substantial consequences. May result in illness or injury. Targets, limits and thresholds of concern regularly exceeded. Will definitely require intervention. Threats of community action. Regular complaints can be expected when the impact takes place.
	M	Moderate change, disturbance or discomfort. Associated with real but not substantial consequences. Targets, limits and thresholds of concern may occasionally be exceeded. Likely to require some intervention. Occasional complaints can be expected.
	L	Minor (Slight) change, disturbance or nuisance. Associated with minor consequences or deterioration. Targets, limits and thresholds of concern rarely exceeded. Require only minor interventions or clean-up actions. Sporadic complaints could be expected.
	VL	Negligible change, disturbance or nuisance. Associated with very minor consequences or deterioration. Targets, limits and thresholds of concern never exceeded. No interventions or clean-up actions required. No complaints anticipated.
	VL+	Negligible change or improvement. Almost no benefits. Change not measurable/will remain in the current range.
	L+	Minor change or improvement. Minor benefits. Change not measurable/will remain in the current range. Few people will experience benefits.
	M+	Moderate change or improvement. Real but not substantial benefits. Will be within or marginally better than the current conditions. Small number of people will experience benefits.
	H+	Prominent change or improvement. Real and substantial benefits. Will be better than current conditions. Many people will experience benefits. General community support.
	VH+	Substantial, large-scale change or improvement. Considerable and widespread benefit. Will be much better than the current conditions. Favourable publicity and/or widespread support expected.
Criteria for ranking the DURATION of impacts	**VL**	Very short, always less than a year. Quickly reversible
	L	Short-term, occurs for more than 1 but less than 5 years. Reversible over time.
	M	Medium-term, 5 to 10 years.
	H	Long term, between 10 and 20 years. (Likely to cease at the end of the operational life of the activity)
	VH	Very long, permanent, +20 years (Irreversible. Beyond closure)
Criteria for ranking the EXTENT of impacts	**VL**	A part of the site/property.
	L	Whole site.
	M	Beyond the site boundary, affecting immediate neighbours
	H	Local area, extending far beyond site boundary.
	VH	Regional/National

PART B: DETERMINING CONSEQUENCE							
			EXTENT				
			A part of the site/property	Whole site	Beyond the site, affecting neighbours	Local area, extending far beyond site.	Regional/ National
			VL	L	M	H	VH
INTENSITY = VL							
DURATION	Very long	VH	Low	Low	Medium	Medium	High
	Long term	H	Low	Low	Low	Medium	Medium
	Medium term	M	Very Low	Low	Low	Low	Medium
	Short term	L	Very low	Very Low	Low	Low	Low
	Very short	VL	Very low	Very Low	Very Low	Low	Low
INTENSITY = L							
DURATION	Very long	VH	Medium	Medium	Medium	High	High
	Long term	H	Low	Medium	Medium	Medium	High
	Medium term	M	Low	Low	Medium	Medium	Medium
	Short term	L	Low	Low	Low	Medium	Medium
	Very short	VL	Very low	Low	Low	Low	Medium
INTENSITY = M							
DURATION	Very long	VH	Medium	High	High	High	Very High
	Long term	H	Medium	Medium	Medium	High	High
	Medium term	M	Medium	Medium	Medium	High	High
	Short term	L	Low	Medium	Medium	Medium	High
	Very short	VL	Low	Low	Low	Medium	Medium
INTENSITY = H							
DURATION	Very long	VH	High	High	High	Very High	Very High
	Long term	H	Medium	High	High	High	Very High
	Medium term	M	Medium	Medium	High	High	High
	Short term	L	Medium	Medium	Medium	High	High
	Very short	VL	Low	Medium	Medium	Medium	High
INTENSITY = VH							
DURATION	Very long	VH	High	High	Very High	Very High	Very High
	Long term	H	High	High	High	Very High	Very High
	Medium term	M	Medium	High	High	High	Very High
	Short term	L	Medium	Medium	High	High	High
	Very short	VL	Low	Medium	Medium	High	High
			VL	L	M	H	VH
			A part of the site/property	Whole site	Beyond the site, affecting neighbours	Local area, extending far beyond site.	Regional/ National
			EXTENT				

PART C: DETERMINING SIGNIFICANCE							
PROBABILITY (of exposure to impacts)	Definite/ Continuous	**VH**	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	Probable	**H**	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	Possible/ frequent	**M**	**Very Low**	**Very Low**	**Low**	**Medium**	**High**
	Conceivable	**L**	**Insignificant**	**Very Low**	**Low**	**Medium**	**High**
	Unlikely/ improbable	**VL**	**Insignificant**	**Insignificant**	**Very Low**	**Low**	**Medium**
			VL	**L**	**M**	**H**	**VH**
			CONSEQUENCE				

PART D: INTERPRETATION OF SIGNIFICANCE	
Significance	**Decision guideline**
Very High	Potential fatal flaw unless mitigated to lower significance.
High	It must have an influence on the decision. Substantial mitigation will be required.
Medium	It should have an influence on the decision. Mitigation will be required.
Low	Unlikely that it will have a real influence on the decision. Limited mitigation is likely to be required.
Very Low	It will not have an influence on the decision. Does not require any mitigation
Insignificant	Inconsequential, not requiring any consideration.

***VH = very high, H = high, M= medium, L= low and VL= very low and + denotes a positive impact.**

7.2 Appendix B – Declaration of Independence

DECLARATION OF INDEPENDENCE - PRACTITIONER

Name of Practitioner: Gillian Petzer
Name of Registration Body: Engineering Council of South Africa (ECSA)
Professional Registration No.: 20170315

Declaration of independence and accuracy of information provided:
Atmospheric Impact Report in terms of section 30 of the Act.
I, Gillian Petzer, declare that I am independent of the applicant. I have the necessary expertise to conduct the assessments required for the report and will perform the work relating the application in an objective manner, even if this results in views and findings that are not favourable to the applicant. I will disclose to the applicant and the air quality officer 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 air quality officer. The additional information provided in this atmospheric impact report is, to the best of my knowledge, in all respects factually true and correct. I am aware that the supply of false or misleading information to an air quality officer is a criminal offence in terms of section 51(1)(g) of this Act.

Signed at Centurion on this 5th of November 2020

SIGNATURE
Principal Air Quality Scientist
CAPACITY OF SIGNATORY

7.3 Appendix C – Curriculum Vitae of Author

CURRICULUM VITAE

Name	Gillian Petzer (née Möhle)
Date of Birth	1 December 1975
Nationality	South African
Employer	Airshed Planning Professionals (Pty) Ltd
Position	Principal Consultant and Project Manager
Profession	Chemical Engineer employed as an Air Quality Assessment Consultant
Years with Firm	15 years

MEMBERSHIP OF PROFESSIONAL SOCIETIES

- South African Institute of Chemical Engineers, 2003 to present
- Institution of Chemical Engineers (IChemE) - Membership number 99964317
- National Association for Clean Air (NACA), 2003 to present
- Professional Engineer – Registration number 20170315

EXPERIENCE

Gillian has fifteen years of experience in air quality impact assessment and management. She is an employee of Airshed Planning Professionals (Pty) Ltd and is involved in the compilation of emission inventories, air pollution mitigation and management, and air pollution impact work.

A list of projects competed in various sectors is given below.

Air Quality Management

- Richards Bay Air Quality Management Plan
- Tshwane Air Quality Management Plan
- Dust Management Plan for various mines

Mining Sector

Lusthof Colliery, South Deep Mine, Kangra, MacWest, Sishen Iron Ore Mine, SA Chrome, Esaase Gold Project (Ghana), Mampon Gold Mine (Ghana), Mittal Newcastle, Navachab (Namibia), Skorpion Zinc mine (Namibia), Debswana Diamond Mines (Botswana). Quarries: Afrisam Pietermaritzburg, AMT operations (Rustenburg and Wonderstone)

Industrial Sector

Various Brickworks, Middelburg Ferrochrome, Impala Platinum (Springs), Delta EMD Project, PetroSA, Alfluorco Aluminium Fluoride Project, PPC, Rand Carbide, Vanchem, BCL incinerator, AEL, Namakwa Sands Plant, Liquid Natural Gas Refinery (Equatorial Guinea), Phalaborwa Mining Company, Asphalt plants, Ceramic facilities

Energy Sector

Walvis Bay Power Station Project (Namibia), various small power stations (Eritrea, Nigeria, Mauritania, Kenya), Matimba Power Station, Mossel Bay OCGT Power Station, Sese Power Station (Botswana), Geothermal Power Station (Kenya)

Waste Disposal and Treatment Sector

Rosslyn and Chloorkop Waste Disposal Sites, Organic waste disposal site

Transport and Logistics Sector

Kolomela Iron Ore Railway Line, Guinea Port and Railway Project (Guinea), Grindrod Coal Terminal, VALE Port Project (Mozambique).

Ambient Air Quality and Noise Sampling

- Gravimetric Particulate Matter (PM) and dustfall sampling
- Passive diffusive gaseous pollutant sampling

SOFTWARE PROFICIENCY

- Atmospheric Dispersion Models: AERMOD, ISC, CALPUFF, ADMS (United Kingdom), CALINE, GASSIM, TANKS
- Graphical Processing: Surfer, ArcGIS (basic proficiency)
- Other: MS Word, MS Excel, MS Outlook

EDUCATION

- BEng: (Chemical Engineering), 2002, University of Pretoria

COURSES COMPLETED AND CONFERENCES ATTENDED

- Conference: NACA (October 2003), Attended
- Conference: NACA (October 2005), Attended and presented a paper
- Conference: NACA (October 2007), Attended and presented a paper
- Conference: NACA (October 2008), Attended and presented a poster
- Conference: NACA (October 2009), Attended and presented a paper
- Conference: NACA (October 2012), Attended
- Conference: IUAPPA (October 2013), Attended
- Course: Climate change and carbon management. Presented by Environmental & Sustainability Solutions (July 2014)
- Conference NACA (October 2016), Attended

COURSES PRESENTED

- National Environmental Management: Air Quality Act and its Implementation (course arranged by the North-West University - NWU)

COUNTRIES OF WORK EXPERIENCE

South Africa, Namibia, Botswana, Ghana, Eritrea, Mauritania, Mozambique, Kenya, Guinea, Equatorial Guinea and Nigeria

LANGUAGES

Language	Proficiency
English	Native language
Afrikaans	Full professional proficiency

REFERENCES

Name	Position	Contact Number
Dr. Gerrit Kornelius	Associate of Airshed Planning Professionals	+27 (82) 925 9569 gerrit@airshed.co.za
Dr Lucian Burger	Director at Airshed Planning Professionals	+27 (82) 491 0385 lucian@airshed.co.za

Dr. Hanlie Liebenberg Enslin	Managing Director at Airshed Planning Professionals	+27 (83) 416 1955 hanlie@airshed.co.za

CERTIFICATION

I, the undersigned, certify that to the best of my knowledge and belief, these data correctly describe me, my qualifications and my experience.

28/09/2017

APPENDIX H: SPECIALIST STUDIES

SOIL, LAND USE, LAND CAPABILITY AND AGRICULTURAL POTENTIAL ASSESSMENT

ZIMPANDE
RESEARCH COLLABORATIVE

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SOIL, LAND USE, LAND CAPABILITY AND AGRICULTURAL POTENTIAL ASSESSMENT AS PART OF THE ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AND AUTHORISATION PROCESS FOR THE PROPOSED VENTILATION SHAFTS AND ASSOCIATED INFRASTRUCTURE AT MARULA PLATINUM MINE, LIMPOPO PROVINCE.

Prepared for

SLR Consulting (Africa) (Pty) Ltd

January 2022

Prepared by: Zimpande Research Collaborative
Report author : T. Setsipane
Report reviewers: S. van Staden (Pr.Sci.Nat)
B. Mzila
Report Reference: ZRC 20-0026
Date: January 2022

EXECUTIVE SUMMARY

The Zimpande Research Collaborative (ZRC) was appointed to conduct a soil, land use, land capability and agricultural potential assessment as part of the environmental impact assessment and authorisation process for the proposed ventilation shafts, ore stockpile, power transmission lines and water pipeline. The proposed development footprint area will hereafter be collectively referred to as the "study area" unless referring to individual infrastructure (i.e., ventilation shaft, stockpile area, power transmission lines and water pipelines etc.).

High agricultural potential land is a scarce non-renewable resource, which necessitates an Agricultural Potential assessment prior to land development, particularly for purposes other than agricultural land use, as per the Conservation of Agricultural Resources Act (CARA), 1983 (Act No. 43 of 1983). High potential agricultural land is defined as land having ''the soil and terrain quality, growing season and adequate available moisture supply to sustain crop production when treated and managed according to best possible farming practices" (Land Capability report ARC, 2006). Land Capability Classification is measured on a scale of I to VIII, with the classes of I to III considered as prime agricultural soils and classes V to VIII not suitable for cultivation.

Based on the observations during the site assessment, the dominant land uses within the study area and the surroundings are mining related activities, with residential areas and wilderness/wildlife being the subdominant land uses. No agricultural activities were observed in the immediate vicinity of the study area.

A total of four (4) soil forms were identified within the study area and these include Spionberg/Valsrivier, Brandvlei, Mispah and Witbank. The agricultural potential of these soil forms ranges from restricted to very low, thus rendering the study area to marginally suitable for cultivated agriculture and under intensive management. The poor agricultural potential of these soil forms can be attributed to their inherent characteristics which include but not limited to:

- Poor drainage characteristics;
- Shallow rooting depth due to high clay content in the B horizon;
- Inadequate moisture;
- Bleached topsoils which lack nutrient retention capacity to support optimum growth and production; and
- Disturbed soils due to anthropogenic influences.

The soils of the Spionberg/Valsrivier are associated with poor physical properties induced by high clay content and very strong structure. The high clay content may effectively reduce water infiltration and thus these soils are more prone to waterlogging conditions as well as intensified runoff during high intensity rainfall. This intensified runoff makes the soils more prone to erosion and thus the formation of gullies which are not favourable for most cultivated crops. The strongly developed structure of the soils may impede root growth and thus limit the area to mostly grazing and/or forestry capability. Nutrient uptake by plants may be limited as these soils tend to hold nutrients tightly to the soil colloids due to the high cation exchange capacity (CEC) caused by high clay content, meaning that more nutrients are held on the soil and are not readily available for plant uptake. Nonetheless, should the soils be cultivated, intensive management practices will have to be implemented.

Brandvlei soil types are associated with the accumulation of calcium carbonate over a long period of time. The pH of these soils increases with depth, typically approaching 8 to 8.5 in the sub-soil. This can potentially induce high capacity for metal cations retention, in so doing potentially reducing agricultural productivity through the deficiency of phosphorus and certain trace elements. Calcic soils are typically low in organic matter due to spatially scattered vegetation in the landscape and rapid decomposition of organic matter in arid areas in which they occur.

Mispah soil types are soils associated with poor physical properties for plant root system penetration and water infiltration, due to the limiting impeding layer of the underlying parent material. These Mispah soils are also highly susceptible to erosion due to their poor hydraulic conductivity, thus not suitable for commercial agricultural cultivation.

Witbank soils are considered of very low agricultural potential due to the soils having been subjected to physical disturbance because of human interventions. Such interventions include transportation and

deposition of the earth material containing soil. As a result, these soils are unable to support agricultural production unless significant amelioration and rehabilitation takes place .

Table A below represents the soil forms identified within the study area as well as their diagnostic horizons, respectively.

Table A: Identified soil forms within the study area and their respective land capability and land potential.

Soil Form	Land capability	Land Potential	Area (ha)	Percentage
Alluvial Watercourse	Class V	Restricted Potential (L6)	1.51	1.8
Spionsberg/Valsrivier	Class VI	Restricted Potential (L5)	69.21	80.4
Brandvlei	Class VI	Restricted Potential (L5)	3.19	1.4
Mispah	Class VIII	Very Low Potential (L8)	14.64	16.5
Total enclosed			**86.12**	**100**

The findings of this assessment suggest that the relevant soil and climatic limiting factors within the study area for land capability and land use potential for agriculture include the following:

- Moderately restricted growing season due to low temperatures, frost and/or moisture stress. Suitable crops may be grown at risk of some yield loss according to the Climate Capability Classification by Scotney *et al*., 1987;
- High clay content of the Spionberg/Valsrivier soil forms affecting rooting depth and moisture content and low nutrient content of Brandvlei soil form;
- Shallow effective rooting depth due to shallow indurated bedrock of the Mispah and Brandvlei soil forms. As such, these soils are not considered able to contribute significantly to agricultural production on a national or provincial scale;
- Susceptibility to erosion of Mispah soils form; and
- Lack of soil medium for plants and crop growth in rocky soils, areas associated with mine infrastructure and no production within surface water areas.

The cumulative loss from a soil and land capability point of view is not anticipated to be significant as the dominant soils within the project footprint area are not considered ideal for cultivation. In addition, the impact on the soils from each footprint area will be localised as each ventilation shaft has a possible footprint area of less than 0.5 hectare, with the longest distance for the proposed water pipelines and power transmission lines being 5.2 km. It should also be noted that large portions of proposed linear infrastructure (i.e. water pipelines) are located within the road reserves where some impact as a result of edge effects has occurred. The stockpile area is already located under the existing infrastructural area and thus not anticipated to cause any significant impact. The study area is surrounded by residential areas as well as wilderness and is isolated from any large-scale agricultural activities in the area. The development of this area is not anticipated to cause a significant cumulative impact since this area is not under current cultivation and the extent of the area to be impacted is limited. The cumulative impact on the local and regional scale is considered medium-low as the dominant soils are not of high importance from a soil and land capability point of view. However, soil is a scarce, non-renewable resource which need to be protected, conserved and managed in compliance with the CARA, 1983 (Act No. 43 of 1983).

The screening tool analysis was conducted, which presented the findings as the impact on agricultural resources being of a High sensitivity rating. However, the screening tool analysis was found to be in contrast with the filed assessment results. The field assessment results indicated that the soils within the footprint areas to be of low agricultural potential, with no prior cultivation for the past 5 years.

Key mitigation measures to minimise impacts on the soil regime include but are not limited to:

- The project operations be kept within the demarcated footprint areas which must be well defined;
- Bare soils within the access roads should be regularly dampened with water to suppress dust during the construction phase, especially when strong wind conditions are predicted according to the local weather forecast;

- A soil monitoring programme should be initiated within the access roads and adjacent areas to ascertain whether the dust suppression has an impact on the soil chemistry; and
- Soil Compaction is usually greatest when soils are moist. Therefore, soils should be stripped when moisture content is as low as possible. If soil must be moved when wet, truck and shovel should be used as bowlscrapers create excessive compaction when moving wet soils.

From a soil and land capability point of view, this project is not regarded as being fatally flawed due to various inherent soil constraints for commercial agricultural production, however mitigation measures and recommendations outlined in this document need to be strongly considered and implemented accordingly in efforts to conserve soil resources.

DOCUMENT GUIDE

Table A: Document guide according to the amended 2017 EIA Regulations (No. R. 326)

No.	Requirement	Section in report
a)	Details of -	
(i)	The specialist who prepared the report	Appendix B
(ii)	The expertise of that specialist to compile a specialist report including a curriculum vitae	Appendix B
b)	A declaration that the specialist is independent	Appendix B
c)	An indication of the scope of, and the purpose for which, the report was prepared	Section 1
cA)	An indication of the quality and age of base data used for the specialist report	Section 3
cB)	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 4 and 5
d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	Section 3
e)	A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Section 3
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 alternative	Section 4
g)	An identification of any areas to be avoided, including buffers	Section 4
h)	A map superimposing the activity including the associated structure and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers	Section 4
i)	A description of any assumption made and any uncertainties or gaps in knowledge	Section 1.1
j)	A description of the findings and potential implication\s of such findings on the impact of the proposed activity, including identified alternatives on the environment or activities	Section 4 and 5
k)	Any mitigation measures for inclusion in the EMPr	Section 5.2
l)	Any conditions for inclusion in the environmental authorisation	Section 4.1
m)	Any monitoring requirements for inclusion in the EMPr or environmental authorisation	None
n)	A reasoned opinion -	
(i)	As to whether the proposed activity, activities or portions thereof should be authorised	Section 5 and 6
(iA)	Regarding the acceptability of the proposed activity or activities	Section 6
(ii)	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	Section 4 and 5
o)	A description of any consultation process that was undertaken during the course of preparing the specialist report	None
p)	A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	None
q)	Any other information requested by the competent authority	None

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GLOSSARY OF TERMS

Albic	Grey colours, apedal to weak structure, few mottles (<10 %)
Alluvial soil:	A deposit of sand, mud, etc. formed by flowing water, or the sedimentary matter deposited thus within recent times, especially in the valleys of large rivers.
Catena	A sequence of soils of similar age, derived from similar parent material, and occurring under similar macroclimatic condition, but having different characteristics due to variation in relief and drainage.
Chromic:	Having within ≤150 cm of the soil surface, a subsurface layer ≥30 cm thick, that has a Munsell colour hue redder than 7.5YR, moist.
Ferralic:	Having a ferralic horizon starting ≤150 cm of the soil surface.
Ferralic horizon:	A subsurface horizon resulting from long and intense weathering, with a clay fraction that is dominated by low-activity clays and contains various amounts of resistant minerals such as Fe, Al, and/or Mn hydroxides.
Gleying:	A soil process resulting from prolonged soil saturation which is manifested by the presence of neutral grey, bluish or greenish colours in the soil matrix.
Hard Plinthic	Accumulative of vesicular Fe/Mn mottles, cemented
Hydrophytes:	Plants that are adaptable to waterlogged soils
Lithic	Dominantly weathering rock material, some soil will be present.
Mottles:	Soils with variegated colour patterns are described as being mottled, with the "background colour" referred to as the matrix and the spots or blotches of colour referred to as mottles.
Plinthic Catena	South African plinthic catena is characterised by a grading of soils from red through yellow to grey (bleached) soils down a slope. The colour sequence is ascribed to different Fe-minerals stable at increasing degrees of wetness
Red Apedal	Uniform red colouring, apedal to weak structure, no calcareous
Runoff	Surface runoff is defined as the water that finds its way into a surface stream channel without infiltration into the soil and may include overland flow, interflow and base flow.
Orthic	Maybe dark, chromic or bleached
Salinity:	High Sodium Adsorption Ratio (SAR) above 15% are indicative of saline soils. The dominance of Sodium (Na) cations in relation to other cations tends to cause soil dispersion (deflocculation), which increases susceptibility to erosion under intense rainfall events.
Sodicity:	High exchangeable sodium Percentage (ESP) values above 15% are indicative of sodic soils. Similarly, the soil dispersion.
Soil Map Unit	A description that defines the soil composition of a land, identified by a symbol and a boundary on a map
Soft Plinthic	Accumulation of vesicular Fe/Mn mottles (>10%), grey colours in or below horizon, apedal to weak structure

ACRONYMS

AGIS	Agricultural Geo-Referenced Information Systems
°C	Degrees Celsius.
CARA	Conservation of Agricultural Resources Act
CEC	Cation Exchange Capacity
DEA	Department of Environmental Affairs
EAP	Environmental Assessment Practitioner
EIA	Environmental Impact Assessment
ET	Evapotranspiration
IUSS	International Union of Soil Sciences
FAO	Food and Agriculture Organization
GIS	Geographic Information System
GPS	Global Positioning System
m	Meter
MAP	Mean Annual Precipitation
NWA	National Water Act
PSD	Particle Size Distribution
SACNASP	South African Council for Natural Scientific Professions
SAS	Scientific Aquatic Services
SOTER	Soil and Terrain
ZRC	Zimpande Research Collaborative

1. INTRODUCTION

The Zimpande Research Collaborative (ZRC) was appointed to conduct a soil, land use, land capability and agricultural potential assessment as part of the environmental impact assessment and authorisation process for the proposed ventilation shafts, ore stockpile, power transmission lines and water pipeline. The proposed development footprint area will hereafter be collectively referred to as the "study area" unless referring to individual infrastructure (i.e., ventilation shaft, stockpile area, power transmission lines and water pipelines etc.). A 50 m zone of influence was applied around the proposed ventilation shafts, power transmission lines and water pipeline to account for the edge effects that will likely occur during all phases of development.

High agricultural potential land is a scarce non-renewable resource, which necessitates an Agricultural Potential assessment prior to land development, particularly for purposes other than agricultural land use, as per Conservation of Agricultural Resources Act (CARA), 1983 (Act No. 43 of 1983). High potential agricultural land is defined as land having ''*the soil and terrain quality, growing season and adequate available moisture supply to sustain crop production when treated and managed according to best possible farming practices"* (Land Capability report ARC, 2006*).* Land Capability Classes (LCC) are used to determine the agricultural potential of soils within the study area due to the positive correlation between the agricultural potential and Land Capability Classification. Land Capability Classification is measured on a scale of I to VIII, with the classes of I to III considered as prime agricultural soils and classes V to VIII not suitable for cultivation. Furthermore, the climate capability is also measured on a scale of 1 to 8, as illustrated in Appendix A.

1.1 Project Description

The study area is located approximately 10 km north of the Driekop town and east of the R37 road. The nearest towns from the study area include Mohlaletsi, Madiseng and Tubatse located approximately 17 km east, 16.5 km south and 23 km west respectively. Refer to Figures 1 and 2 indicating the locality of the study area.

Marula now proposes to change their approved layout by establishing additional surface infrastructure, which will require an amendment to Marulas' approved EMPr. The proposed additional surface infrastructure comprises the following:

- The establishment of two additional ventilation shafts;
- The upgrade to refrigeration and ventilation infrastructure at existing ventilation shafts;

- The establishment of additional water pipelines to support the additional ventilation shafts;
- The expansion and establishment of additional power supply and distribution infrastructure in support of the establishment of additional ventilation shaft and upgrades to existing ventilation shafts);
- The establishment of a product stockpile within the existing footprint of the Concentrator Plant;
- The establishment of an additional pipeline to the approved Tailings Storage Facility (TSF); and
- Structural upgrades of the existing change house and compressed airline at the Clapham Shaft Complex.

a. Ventilation shafts and upgrades to refrigeration infrastructure

Marula proposes to establish two new additional ventilation shafts within their existing MRA. An upcast and downcast shaft is proposed. The downcast shafts are used to draw clean air into the underground mine workings, whilst the upcast shaft will vent the “dirty/used” air to the surface. There are also existing ventilation shafts on Driekop 253 KT (Ventilation Shaft 6) and Winnarshoek 250 KT (Ventilation Shaft 5). Ventilation Shaft 7 (located on Winnarshoek 250 KT) was approved as part of the Merensky Reef project but is not constructed to date. An overview of these activities is summarised in Table 1 and Table 2 below.

Table 1: Proposed ventilation infrastructure.

Aspect	Detail	
Proposed establishment of new ventilation shafts - Driekop Shaft	Name	Ventilation Shaft 9.
	Location	Driekop 253 KT (Portion 0)
	Footprint	Within approved footprint of Driekop Shaft 6.
	Technology	Upcast shaft.
	Refrigeration or ventilation infrastructure	Establishment of a new ventilation shaft with surface main fans and electrical rooms.
Proposed establishment of new ventilation shafts - Clapham Shaft	Name	Ventilation Shaft 8.
	Location	Winnarshoek 250 KT (Portion 0)
	Footprint	Approximately 0.5 ha.
	Technology	Downcast shaft.
	Refrigeration or ventilation infrastructure	Establishment of a new bulk air cooler. Establishment of refrigeration plant and condenser cooling towers.

Table 2: Proposed upgrades of ventilation and refrigeration infrastructure.

Aspect	Detail	
Proposed changes and upgrades at existing infrastructure - Driekop Shaft	Name	Ventilation Shaft 6
	Refrigeration or ventilation infrastructure	Establishment of a new bulk air cooler. Establishment of a refrigeration plant and condenser cooling towers.
	Location of infrastructure	Driekop 253 KT (Portion 0)
	Footprint	Within the existing, approved footprint of the Driekop VS 6 shaft area.
Proposed changes and upgrades at existing infrastructure - Clapham Shaft	Name	Ventilation Shaft 5
	Refrigeration or ventilation infrastructure	Establishment of a new bulk air cooler.
	Location of infrastructure	Winnarshoek 250 KT (Portion 0)
	Footprint	Within the existing, approved footprint of the Clapham VS 5 shaft area.
	Name	Ventilation Shaft 7 (Approved but not constructed)
	Refrigeration or ventilation infrastructure	Establishment of surface main fans and electrical rooms.
	Location of infrastructure	Winnarshoek 250 KT (Portion 0)
	Footprint	Approximately 1.8 ha.

b. Upgrades of existing services and infrastructure

Water supply and distribution

Water supply: Raw water required for the proposed project will be sourced from the existing on-site Lebalelo Raw Water Dam (Plant Dam). Marula has sufficient capacity and volume to accommodate the proposed project water requirements and as such no changes are anticipated to the existing water reticulation storage capacities (Plant Dam) or supply demand.

Distribution: The proposed project will require the establishment of pipelines from the Plant Dam to the new ventilation shafts (Driekop Ventilation Shaft 9 and Clapham Ventilation Shaft 8). The proposed HDPE pipelines will have a diameter of approximately 150 mm (0.15 cm) and will be below ground. The proposed pipeline to the Clapham Ventilation Shaft 8 will be approximately 2.1 km in length with a throughput of 24 l/s. The proposed Driekop Ventilation Shaft 9 pipeline will be approximately 5.2 km in length with a throughput of 24 l/s. The water supply pipeline will be fed into the plant room and subsequently through to the cooling tower. The establishment of the proposed Driekop water supply pipeline will have a total area of disturbance of 5 250 m^2/ 0.525 Ha. The establishment of the proposed Clapham water supply pipeline will have a total area of disturbance of 13 000 m^2 / 1.3 Ha.

Wastewater: Wastewater which contains an elevated salt concentration will emanate from the refrigeration process. This wastewater will be pumped into a surface sump (with approximate

dimension of 2 m by 2 m). A return pipeline of approximately 50 mm will carry this wastewater back to the Concentrator Plant. The return pipeline will be located within the same below ground trench as the water supply pipeline to the ventilation shafts and will thus not result in any additional land clearance.

Power supply and transmission

Supply: Power is currently supplied to the mine by a consumer Eskom substation which is comprised of 2 x 20 MVA transformers. The power demand is expected to exceed the output from the 2 x 20 MVA transformer in 2025. In addition, the power requirements for the establishment of the new Clapham Ventilation Shaft 8 will need to be accommodated. Marula therefore proposes to increase the existing Eskom yard capacity to 60 MVA by the addition of a 40 MVA transformer. The running load will be 54 MVA. Existing power supply infrastructure is sufficient to support the project components at the remaining ventilation shafts.

Distribution: A new 33 kV overhead transmission line will be established from the on-site Eskom yard to the Clapham Ventilation Shaft 8. A new 33 kV overhead transmission line will also be established from the Driekop Shaft Complex to the new Driekop Ventilation Shaft 9, to supply the new ventilation shaft with power. The new 33 kV overhead transmission line will then be fed into a new step-down transformer located at the Clapham and Driekop ventilation shafts. The 33 kV will be stepped down to 11 kV and then fed into the plant room and ventilation fans. The lengths of the Clapham Ventilation Shaft 8 and the Driekop Ventilation Shaft 9 will be 3.8 km and 3.3 km, respectively.

Disturbance to watercourses: Watercourses within the proposed project area include the Tshwenyane, Mogompane, Motse Rivers and an unnamed tributary of the Moopetsi River (with riparian vegetation), as well as numerous non-perennial and ephemeral drainage lines. The proposed power distribution lines and tower bases will be located within 32 m the existing watercourses. A water use license (WUL) will need to be applied for due to this disturbance, however this will be undertaken separately from this Basic Assessment process.

c. Establishment of a product stockpile

In order to alleviate storage capacity constraints experienced with their current operations, Marula proposes the establishment of an additional product stockpile. The additional product stockpile will reach a maximum capacity of 200 000 tons and will be located within the existing, disturbed footprint of the Concentrator Plant. The proposed location of the product stockpile is disturbed but unlined. The product material is similar to the mine's existing tailings and is considered low grade ore. The 2015 geochemical waste assessment undertaken by Golder

(Golder, 2015) detailed that the tailings material is classified as a Type 3 waste. The results of the assessment indicated that NO_3 leachate concentrations exceeded the TCT0 threshold in two of the tailing composites. The material was reported to require a Class C liner. Marula will further investigate the liner requirements for the proposed stockpile as part of their WUL application which will be undertaken as a separate process.

Figure 1: Conceptual design of the proposed product stockpile.

d. TSF pipeline

To increase the operational efficiency at the mine, an additional tailings conveyance pipeline is proposed. The proposed additional pipeline will follow the existing overland pipeline route which runs from the Concentrator Plant to the Phase 2 TSF. The additional pipeline will be 4 km in length with an internal diameter of 243 mm and comprised of HDPE lined steel.

Table 3: Locality of the TSF pipeline

Start point	S24° 30' 3.762" E30° 4' 21.895"
Middle point	S24° 30' 30.037" E30° 5' 16.393"
End point	S24° 30' 32.641" E30° 6' 12.020"

e. Upgrade to existing change house (including lamp room) and compressed airline

The current change house and lamp room at the Clapham Shaft Complex has reached its current capacity. An upgrade of the change house (and lamp rooms) is now proposed to accommodate an increase of the labour force for 600 people. The actual construction timeline is expected to begin in 2024 / 2025.. In addition to the upgrade of the Clapham change house, the existing 400 NB compressed air ring main from compressor house to Clapham UG mine will be upgraded from 400 NB to 600 NB. No change to the pipeline pressure is anticipated. The structural upgrades of the change house and compressed air ring main will be undertaken within the existing and disturbed Clapham Shaft Complex footprint and no additional land clearance will be required.

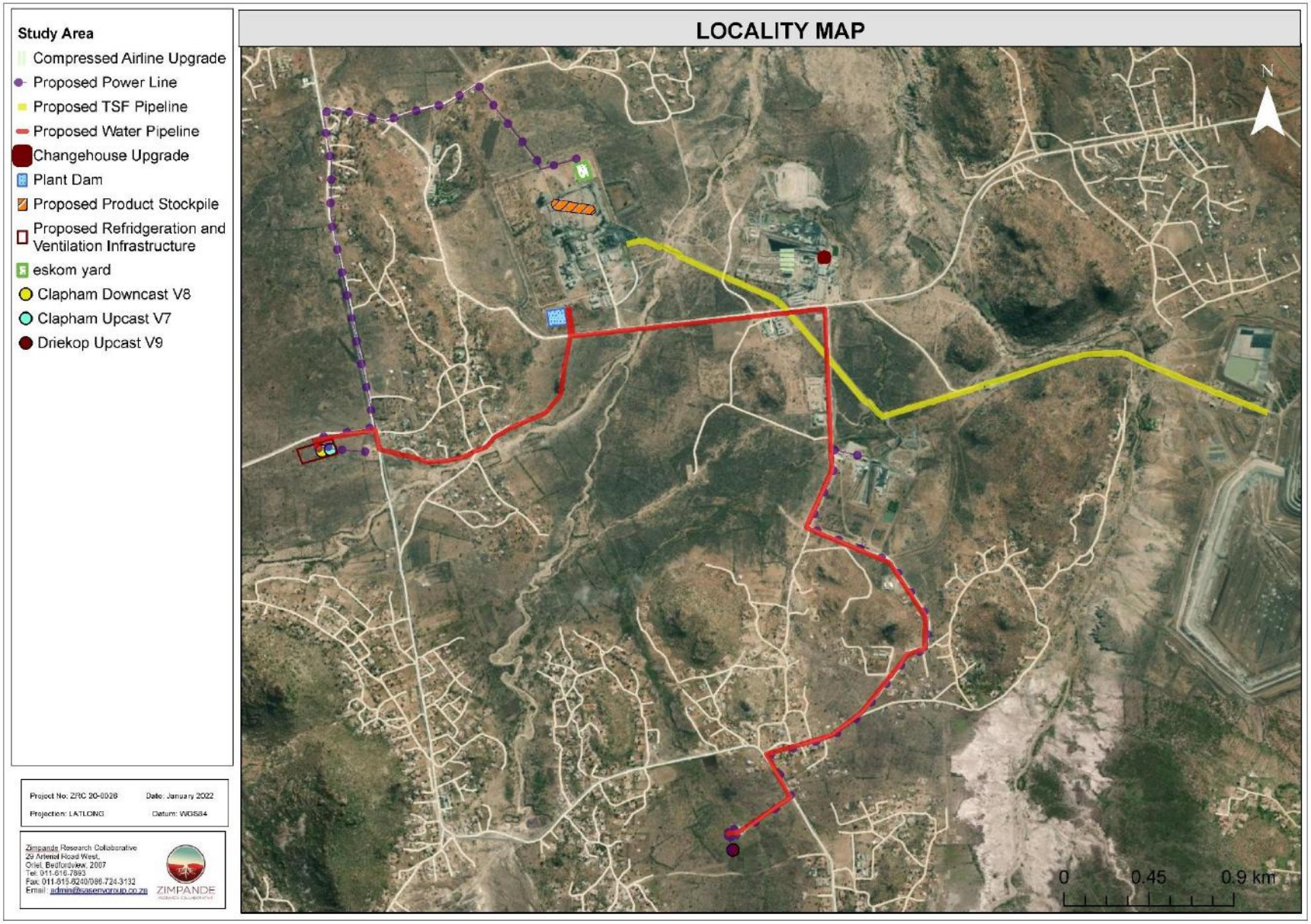

Figure 2: Digital satellite imagery depicting the locality of the study area in relation to the surrounding area.

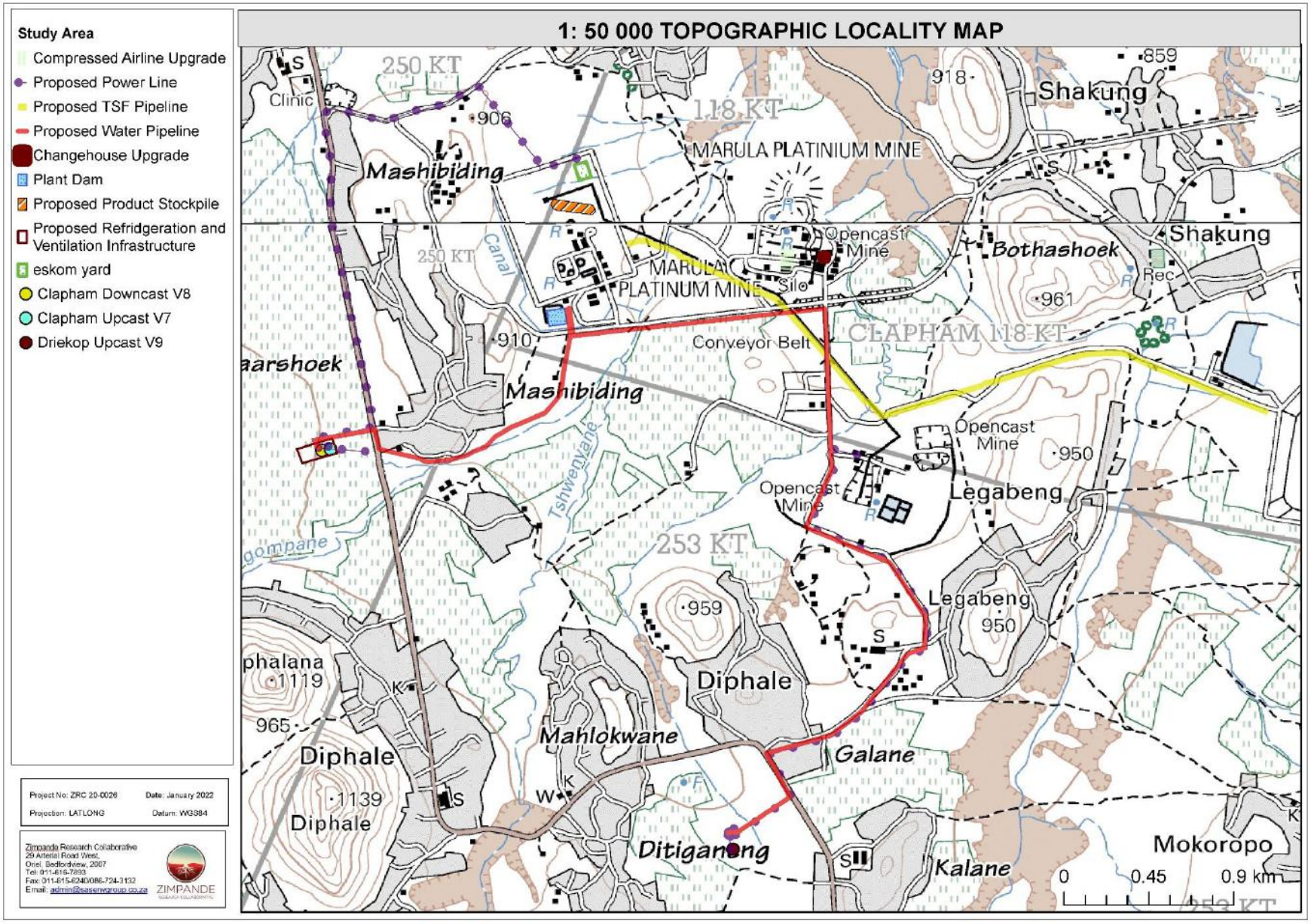

Figure 3: Location of the study area depicted on a 1:50 000 topographical map in relation to surrounding area.

1.2 Terms of Reference and Scope of Work

The soil, land use, land capability and agricultural potential assessment which formed part of the Environmental Authorisation process entailed the following aspects:

- As part of the desktop study various data sets were consulted which includes but not limited to Soil and Terrain dataset (SOTER) to review the geology, landform and land capability to establish broad baseline conditions and sensitivity of study area both on environmental and agricultural perspective;
- Compile various maps depicting the on-site conditions based on desktop review of existing data;
- Classification of the climatic conditions occurring within the study area;
- Conduct a soil classification survey within the proposed development footprint;
- Assess the spatial distribution of various soil types within the study area and classify the dominant soil types according to the South African Soil Classification System: A Natural and Anthropogenic System for South Africa (Soil Classification Working Group, 2018);
- Identify restrictive soil properties on land capability under prevailing conditions;
- Identify and assess the potential impacts in relation to the proposed development using pre-defined impact assessment methodology; and
- Compile soil, land use and land capability report under current on-site conditions based on the field finding data.

1.3 Assumptions and Limitations

For the purpose of this assessment, the following assumptions are applicable:

- The soil survey conducted as part of the land capability assessment was confined within the study area outline. This includes linear and surface infrastructure; and
- Land capability was classified according to the current soil restrictions, with respect to prevailing climatic conditions on site; however, it is virtually impossible to achieve 100% purity in soil mapping, the delineated soil map units could include other soil type(s) as the boundaries between the mapped soils are not absolute but rather form a continuum and gradually change from one type to another. Soil mapping and the findings of this assessment were therefore inferred from extrapolations from individual observation points.

2. METHOD OF ASSESSMENT

2.1 Literature and Database Review

Prior to commencement of the field assessment, a background study, including a literature review, was conducted to collect the pre-determined soil, land use and land capability data in the vicinity of the investigated study area. Various data sources including but not limited to the Agricultural Geo-Referenced Information System (AGIS) and other sources as listed under references were utilized to fulfil the objectives for the assessment.

2.2 Soil Classification and Sampling

A soil survey was conducted in November 2020, at which time the identified soils within the study area classified into soil forms according to the Soil Classification System: A Natural and Anthropogenic System for South Africa Soil Classification System (2018). This survey period is deemed appropriate since seasonality does not have an effect on the soil characteristics. Subsurface soil observations were made using a manual hand auger in order to assess individual soil profiles, which entailed evaluating physical soil properties and prevailing limitations to various land uses.

2.3 Land Capability Classification

Agricultural potential is directly related to Land Capability, as measured on a scale of I to VIII, as presented in Table 4 below; with Classes I to III classified as prime agricultural land that is well suited for annual cultivated crops, whereas, Class IV soils may be cultivated under certain circumstances and specific or intensive management practices, and Land Classes V to VIII are not suitable to cultivation. Furthermore, the climate capability is also measured on a scale of C1 to C8, as illustrated in Table 5 below. The land capability rating is therefore adjusted accordingly, depending on the prevailing climatic conditions as indicated by the respective climate capability rating. The anticipated impacts of the proposed land use on soil and land capability were assessed in order to inform the necessary mitigation measures.

Table 4: Land Capability Classification (Smith, 2006).

Land Capability Class	Increased Intensity of Use									Land Capability Groups
I	W	F	LG	MG	IG	LC	MC	IC	VIC	**Arable land**
II	W	F	LG	MG	IG	LC	MC	IC		
III	W	F	LG	MG	IG	LC	MC	IC		
IV	W	F	LG	MG	IG	LC				
V	W		LG	MG						**Grazing land**

VI	W	F	LG	MG						
VII	W	F	LG							
VIII	W									**Wildlife**

W- Wildlife	MG- Moderate grazing	MC- Moderate cultivation
F- Forestry	IG- Intensive grazing	IC- Intensive cultivation
LG- Light grazing	LC- Light cultivation	VIC- Very intensive cultivation

Table 5: Climate Capability Classification (Scotney et al., 1987).

Climate Capability Class	Limitation Rating	Description
C1	None to slight	Local climate is favourable for good yield for a wide range of adapted crops throughout the year.
C2	Slight	Local climate is favourable for good yield for a wide range of adapted crops and a year round growing season. Moisture stress and lower temperatures increase risk and decrease yields relative to C1.
C3	Slight to moderate	Slightly restricted growing season due to the occurrence of low temperatures and frost. Good yield potential for a moderate range of adapted crops.
C4	Moderate	Moderately restricted growing season due to low temperatures and severe frost. Good yield potential for a moderate range of adapted crops but planting date options more limited than C3.
C5	Moderate to severe	Moderately restricted growing season due to low temperatures, frost and/or moisture stress. Suitable crops may be grown at risk of some yield loss.
C6	Severe	Moderately restricted growing season due to low temperatures, frost and/or moisture stress. Limited suitable crops for which frequently experience yield loss.
C7	Severe to very severe	Severely restricted choice of crops due to heat, cold and/or moisture stress.
C8	Very severe	Very severely restricted choice of crops due to heat and moisture stress. Suitable crops at high risk of yield loss.

The land potential assessment entails the combination of climatic, slope and soil condition characteristics to determine the agricultural land potential of the investigated area. The classification of agricultural land potential and knowledge of the geographical distribution of agricultural viable land within an area of interest. This is of importance for making an informed decision about land use. Table 6 below presents the land potential classes, whilst Table 7 presents a description thereof, according to Guy and Smith (1998).

Table 6: Table of Land Potential Classes (Guy and Smith, 1998).

Land Capability Class	Climate Capability Class							
	C1	C2	C3	C4	C5	C6	C7	C8
I	L1	L1	L2	L2	L3	L3	L4	L4
II	L1	L2	L2	L3	L3	L4	L4	L5
III	L2	L2	L3	L3	L4	L4	L5	L6
IV	L2	L3	L3	L4	L4	L5	L5	L6
V	Vlei	Vlei	Vlei	Vlei	Vlei	Vlei	Vlei	Vlei
VI	L4	L4	L5	L5	L5	L6	L6	L7
VII	L5	L5	L6	L6	L7	L7	L7	L8
VIII	L6	L6	L7	L7	L8	L8	L8	L8

Table 7: The Land Capability Classes Description (Guy and Smith, 1998).

Land Potential	Description of Land Potential Class
L1	**Very high potential:** No limitations. Appropriate contour protection must be implemented and inspected.
L2	**High potential:** Very infrequent and/or minor limitations due to soil, slope, temperatures or rainfall. Appropriate contour protection must be implemented and inspected.
L3	**Good potential:** Infrequent and/or moderate limitations due to soil, slope, temperatures or rainfall. Appropriate contour protection must be implemented and inspected.
L4	**Moderate potential:** Moderately regular and/or severe to moderate limitations due to soil, slope, temperature or rainfall. Appropriate permission is required before ploughing virgin land.
L5	**Restricted potential:** Regular and/or moderate to severe limitations due to soil, slope, temperature or rainfall.
L6	**Very restricted potential:** Regular and/or severe limitations due to soil, slope, temperature or rainfall. Non-arable.
L7	**Low potential:** Severe limitations due to soil, slope, temperature or rainfall. Non-arable.
L8	**Very low potential:** Very severe limitations due to soil, slope, temperature or rainfall. Non-arable.

3. DESKTOP ASSESSMENT RESULTS

**It should be noted that some of the database used in this assessment are not the most recent available, thus inaccuracies may exist in the data presented. However, the data presented gives useful background information of the surroundings in terms of the prevailing soil and climatic conditions.*

The following data is applicable to the study area, according to various data sources including but not limited to the Agricultural Geo-referenced Information System (AGIS).

- The Mean Annual Precipitation (MAP) in the vicinity of the study area is estimated to range between 401 and 600 mm per annum. These conditions have a low yield potential for a moderate range of adapted crops but planting date options are limited for supporting rain fed agriculture;
- The Mean Annual Evaporation for the majority of the study area ranges between 2201 and 2200 mm per annum. The high evaporation rates pose risks to plant yield due possible plant permanent wilting resulting in plant desiccation and lack of adequate soil moisture;
- According to the Geology 2001 and the 1:250 000 geological map of South Africa the study area is predominantly underlain by the Rustenburg, Lebowa and Rashoop geological types;
- The dominant parent material for the majority of the study area is the Gabbro;
- The dominant Landform type occurring within the study area is Plain. which means the terrain is suitable to allow agricultural activities;
- The Soil and Terrain (SOTER) database indicates that the majority of the study area is comprised of Calcic Vertisols. These soils are suitable for agricultural cultivation under intensive management;

- The predicted soil loss for the majority of the study area is considered very high;
- The majority of the study area is non-susceptible to wind erosion;
- According to the AGIS database, livestock grazing capacity potential for the majority of the study area is estimated to be approximately 14 - 17 hectares per large animal, the south-western portions of the study area have a potential livestock grazing capacity of 11 - 13 and the north-eastern portion a potential grazing capacity of 18–21 (Figure 4);
- Beneficial water retaining characteristics are scarce or absent;
- According to the AGIS database, the soil medium occurring within the study area is not considered to be saline or sodic; and
- The pH of the most soils occurring within the study area are alkaline with pH range of 7.5 - 8.4. This pH range is suitable for majority of cultivated crops.

Department of Environmental Affairs (DEA) screening tool:

The screening tool was compiled as required by the Environmental Impact Assessment (EIA) Regulations 2014. The findings of the screening tool indicated a high sensitivity to agriculture for the footprint areas, however this analysis was not consistent with the field assessment results as detailed by the site verification (Section 6).

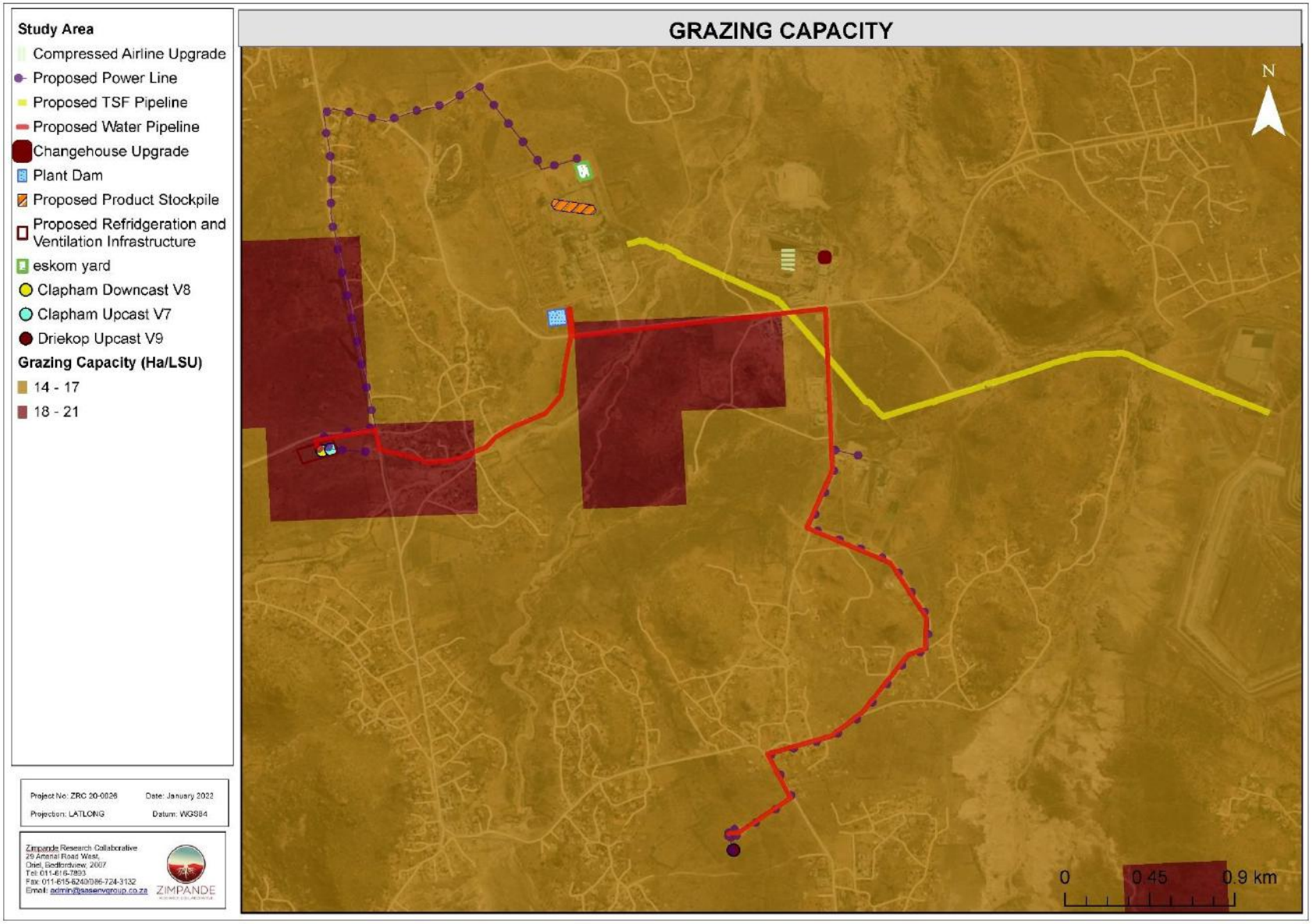

Figure 4: Map depicting the grazing capacity (Ha/LSU) associated with the study area.

4. ASSESSMENT RESULTS

4.1 Current Land Use

Based on the observations during the site assessment, the dominant land uses within the study area are mining related activities, with the sub-dominant uses being residential areas and wilderness/wildlife. No agricultural activities were observed in the immediate vicinity of the study area. Refer to Figure 5 for examples of the current land uses associated with the study area.

Figure 5: Photographs illustrating the dominant land use associated with the study area.

4.2 Dominant Soil Forms

The study area is dominated by marginal to low agricultural potential soils (Spionberg/Valsrivier and Brandvlei). In total, four (4) soil forms were identified within the study area and these include Spionberg/Valsrivier, Brandvlei, Mispah and Witbank. In addition, some rocky outcrops were identified along the study area and transformed soils being used as roads and recreational areas.

The dominant soils of Spionberg/Valsrivier, Brandvlei, Mispah and Witbank are not considered ideal for cultivation due to:

- Poor drainage characteristics;
- Shallow rooting depth due to high clay content in the B horizon;
- Inadequate moisture;
- Bleached topsoils which lack nutrient retention capacity to support optimum growth and production; and
- Disturbed soils due to anthropogenic influences.

The soils of the Spionberg/Valsrivier are associated with poor physical properties induced by high clay content and very strong structure. The high clay content may effectively reduce water infiltration and thus these soils are more prone to waterlogging conditions as well as intensified runoff during high intensity rainfall. This intensified runoff makes the soils more prone to erosion and thus the formation of gullies which are not favourable for most cultivated crops. The strongly developed structure of the soils may impede root growth and thus limit the area to mostly grazing and/or forestry capability. Nutrient uptake by plants may be limited as these soils tend to hold nutrients tightly to the soil colloids due to the high cation exchange capacity (CEC) caused by high clay content, meaning that more nutrients are held on the soil and are not readily available for plant uptake. Nonetheless, should the soils be cultivated, intensive management practices will have to be implemented.

Brandvlei soil types are associated with the accumulation of calcium carbonate over a long period. The pH of these soils increases with depth, typically approaching 8 to 8.5 in the sub-soil (Fey, 2010). This can potentially induce high capacity for metal cations retention, in so doing potentially reducing agricultural productivity through the deficiency of phosphorus and certain trace elements. Calcic soils are typically low in organic matter due to spatially scattered vegetation in the landscape and rapid decomposition of organic matter in arid areas in which they occur (Fey, 2010).

The Mispah soil type is associated with poor physical properties for plant root system penetration and water infiltration, due to the limiting impeding layer of the underlying parent material. The Mispah soil form is also highly susceptible to erosion due to the poor hydraulic conductivity of these soils and thus not suitable for commercial agricultural cultivation.

Witbank soils are considered of very low agricultural potential due to the soils having been subjected to physical disturbance because of human interventions. Such interventions include transportation and deposition of the earth material containing soil. As a result, these soils are

unable to support agricultural production unless significant amelioration and rehabilitation takes place.

The soils within the study area can be broadly classified as not capable of supporting agricultural cultivation practices unless an intensive management practice is applied. However, grazing activities as well as wildlife/wilderness can be supported. Table 8 below represents the soil forms identified within the study area as well as their diagnostic horizons respectively. Figures 6, 7, 8 and 9 illustrates the dominant soil forms associated with the study area.

Table 8: Dominant soil forms within the study area.

Soil Form	Code	Diagnostic Horizon Sequence
Spionsberg/Valsrivier	Sb/Va	Orthic A/Pedocutanic or Hardrock
Brandvlei	Br	Orthic A/Soft Carbonate/Hardrock or Hard Carbonate
Mispah	Ms	Orthic A/Hard Rock
Witbank	Wt	Anthrosols

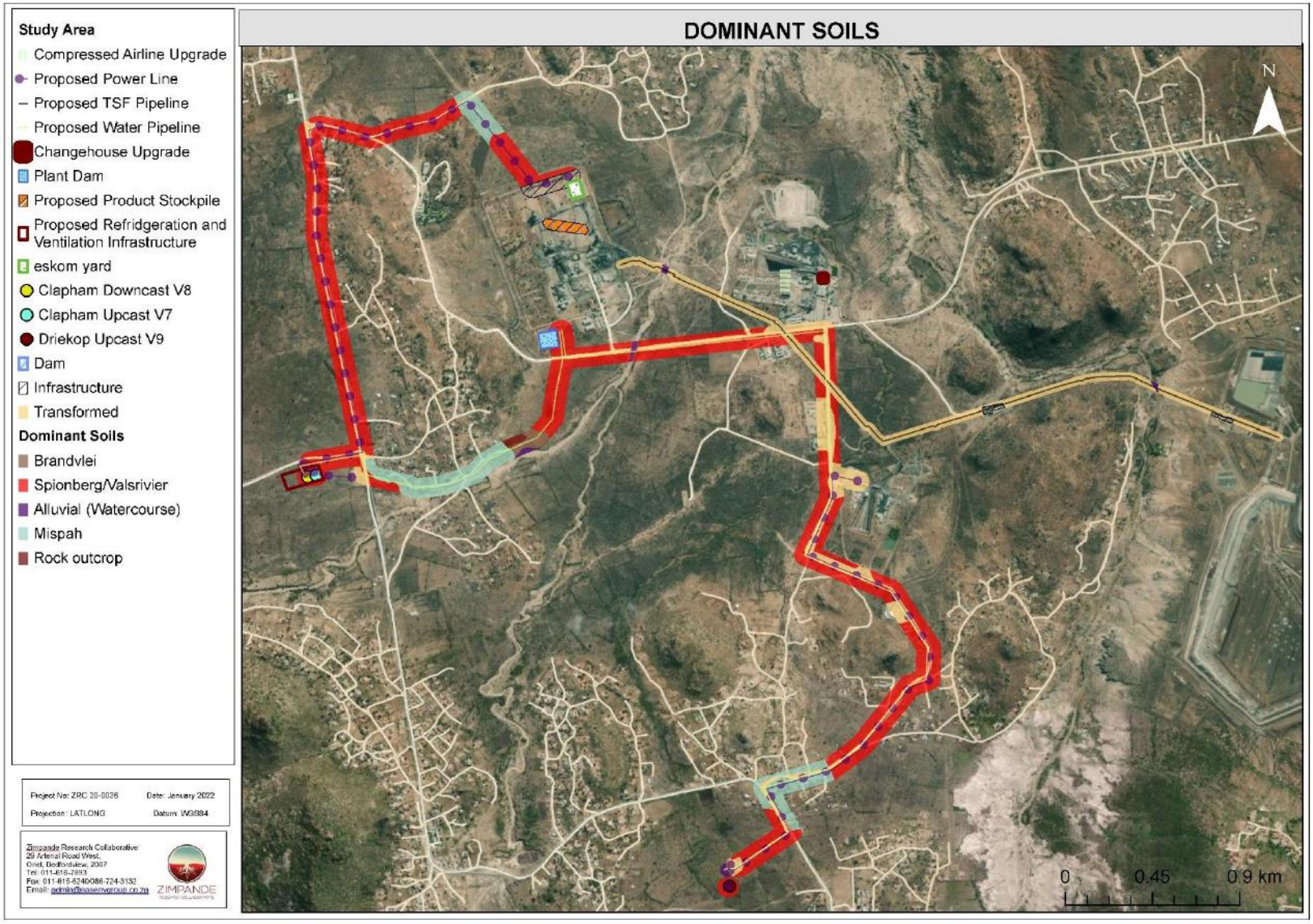

Figure 6: Dominant soils forms within the study area.

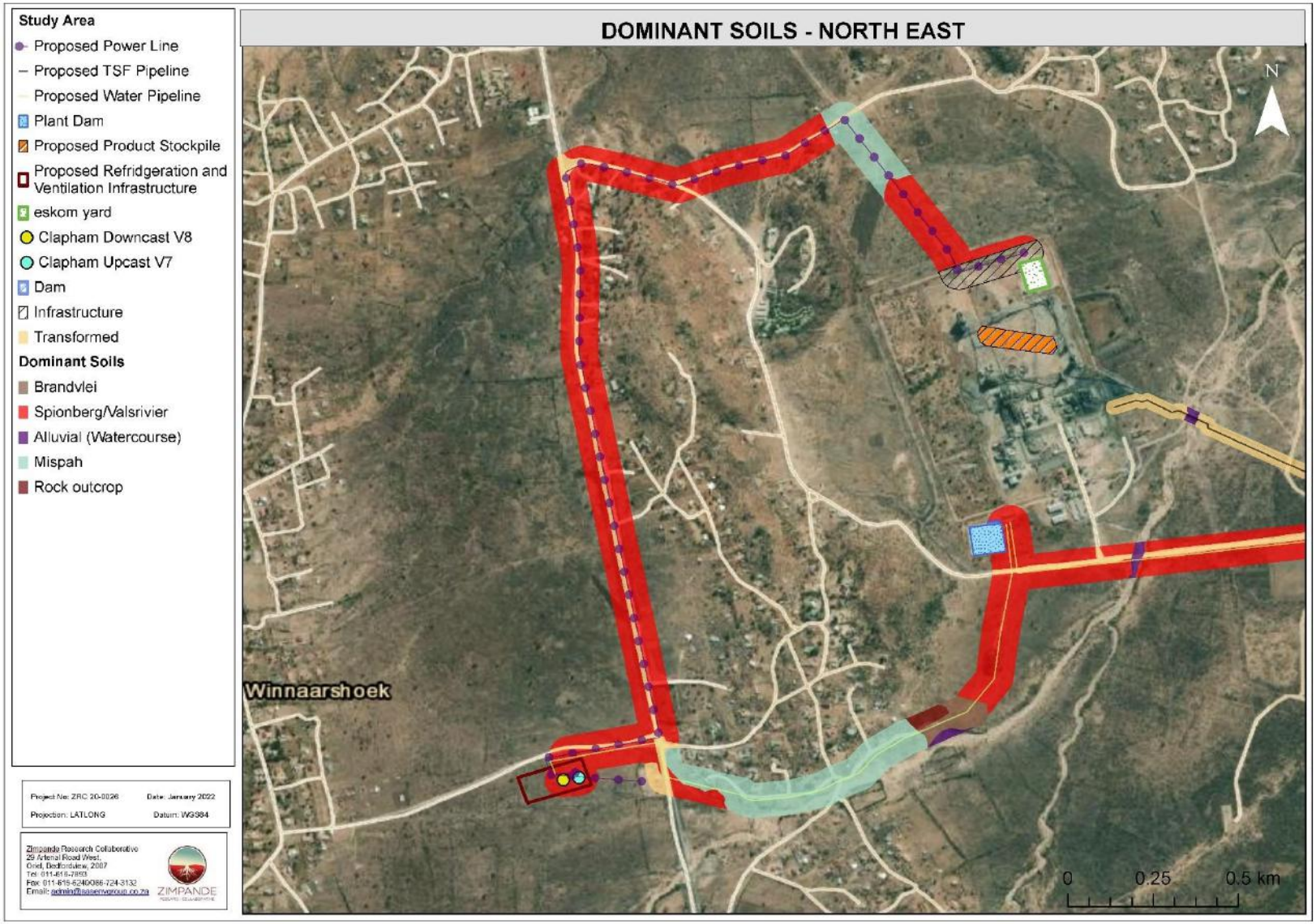

Figure 7: Dominant soils forms within the north-eastern portion of the study area.

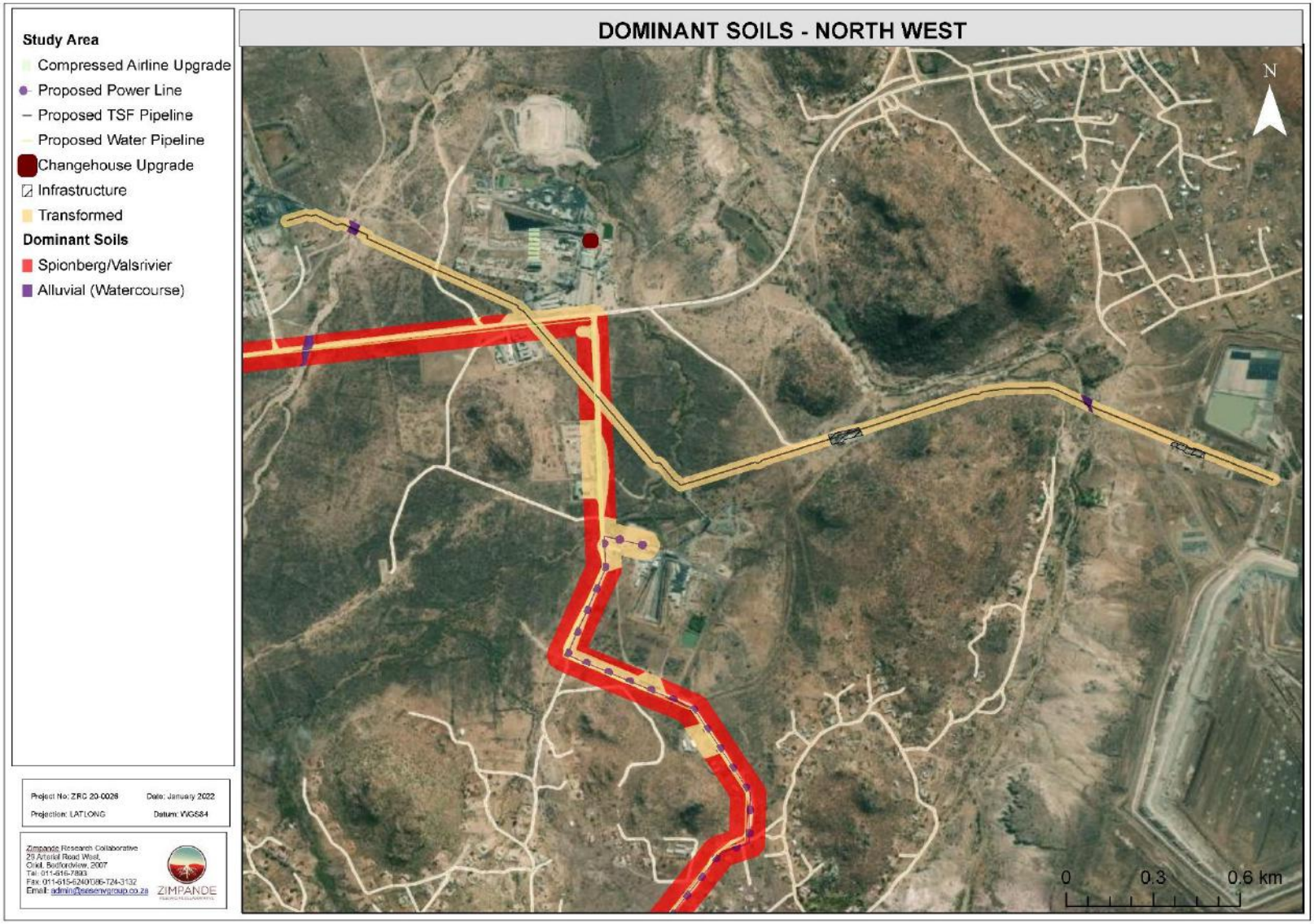

Figure 8: Dominant soils forms within the north-western portion of the study area.

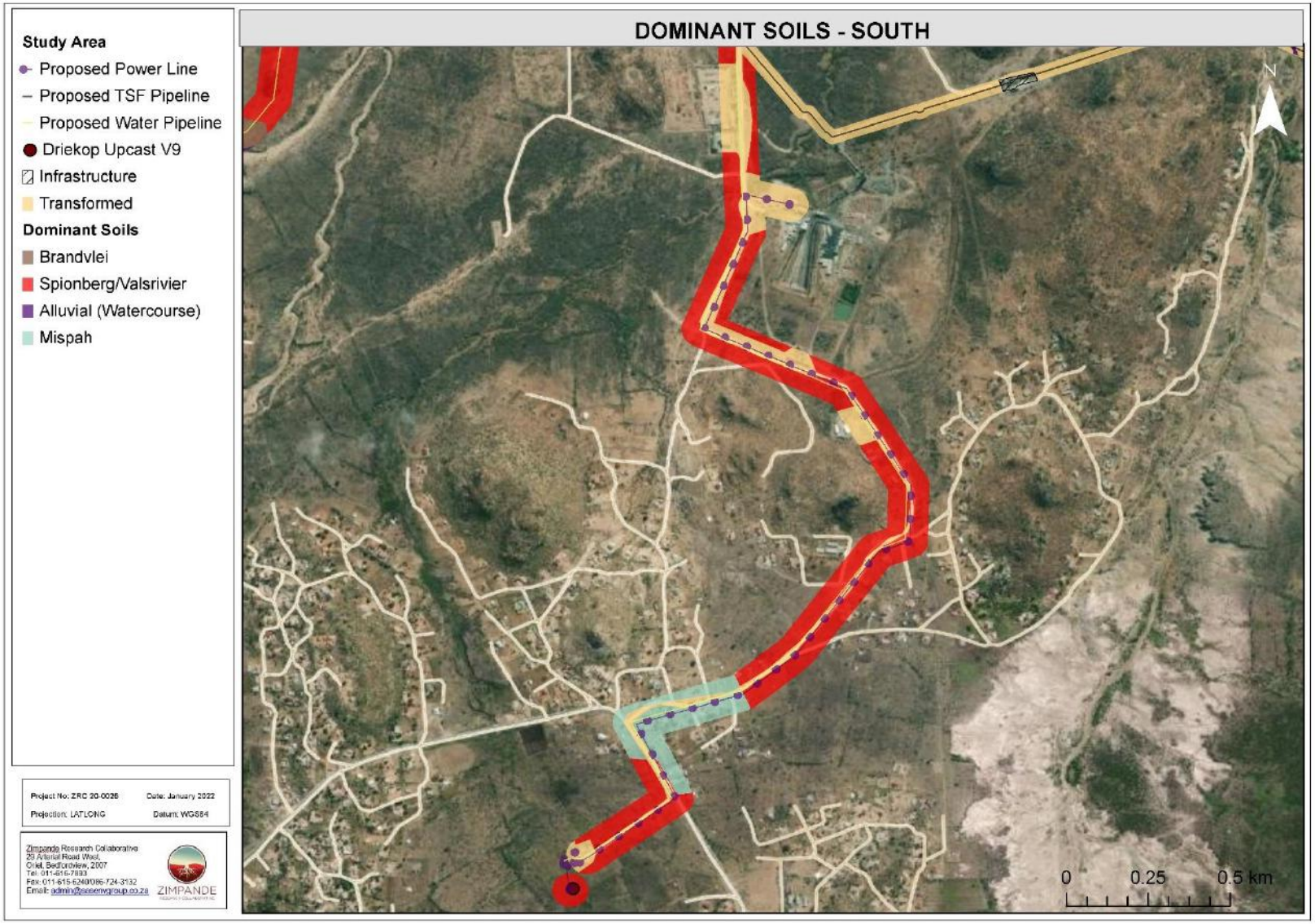

Figure 9: Dominant soils forms within the southern portion of the study area.

4.3 Land Capability Classification

Agricultural land capability in South Africa is generally restricted by climatic conditions, with specific mention to water availability (rainfall). Even within similar climatic zones, different soil types typically have different land use capabilities attributed to their inherent characteristics. High potential agricultural land is defined as having the soil and terrain quality, growing season and adequate available moisture supply needed to produce sustained economically high crop yields when treated and managed according to best possible farming practices (Scotney *et al*., 1987).

For the purpose of this assessment, land capability was inferred in consideration of observed limitations to land use due to physical soil properties and prevailing climatic conditions. Climate Capability (measured on a scale of 1 to 8) was therefore considered in the agricultural potential classification. The study area falls into Climate Capability Class 5 due to low rainfall and high temperatures, with low yield potential for a limited range of adapted crops.

The identified soils were classified into land capability and land potential classes using the Camp *et. al*, and Guy and Smith Classification system (Camp *et al.,* 1987; Guy and Smith, 1998), as presented from Figure **10**. The identified land capability limitations for the identified soils are discussed in comprehensive "dashboard style" summary tables presented from Tables **10, 11** and **12** below. The dashboard reports aim to present all the pertinent information in a concise and visually appealing fashion. **Table 9** below presents the dominant soil forms and their respective land capability, land potential as well as areal extent expressed as hectares as well as percentages. Figure **11** depicts the land potential of the soils in terms of agriculture attributable to their cultivability. The agricultural land potential was found to be in contrast to the findings of the DEA screening tool.

Table 9: Identified soil forms within the study area and their respective land capability and land potential.

Soil Form	Land capability	Land Potential	Area (ha)	Percentage
Alluvial Watercourse	Class V	Restricted Potential (L6)	1.51	1.8
Spionsberg/Valsrivier	Class VI	Restricted Potential (L5)	69.21	80.4
Brandvlei	Class VI	Restricted Potential (L5)	3.19	1.4
Mispah	Class VIII	Very Low Potential (L8)	14.64	16.5
Total enclosed			**86.12**	**100**

***Infrastructural areas 6.4 ha (4.9%) and transformed 38.27 ha (23.3%) areas were not included in the table above since they not considered in the land capability ratings.**

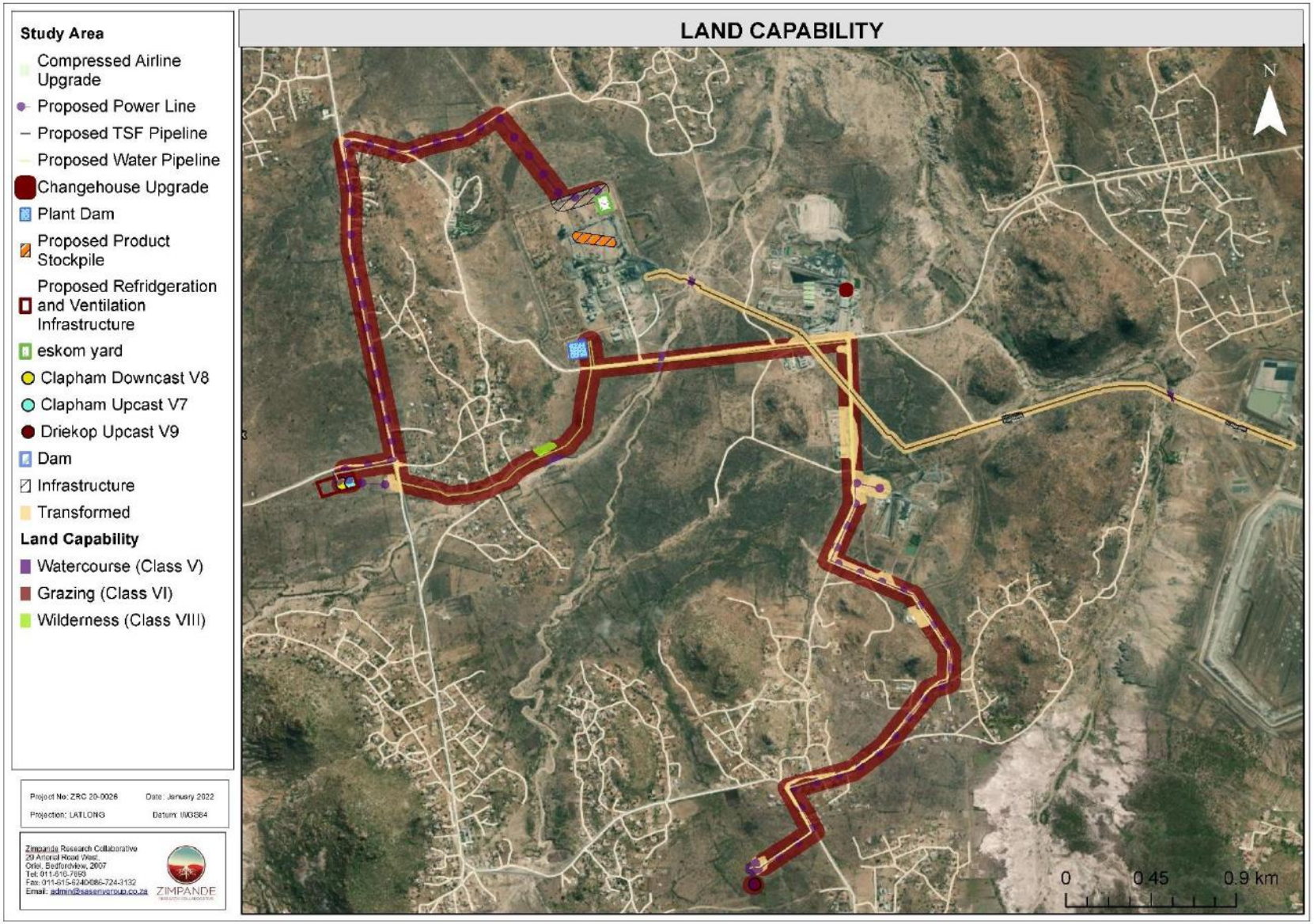

Figure 10: Map depicting Land capability of soils occurring within the study area.

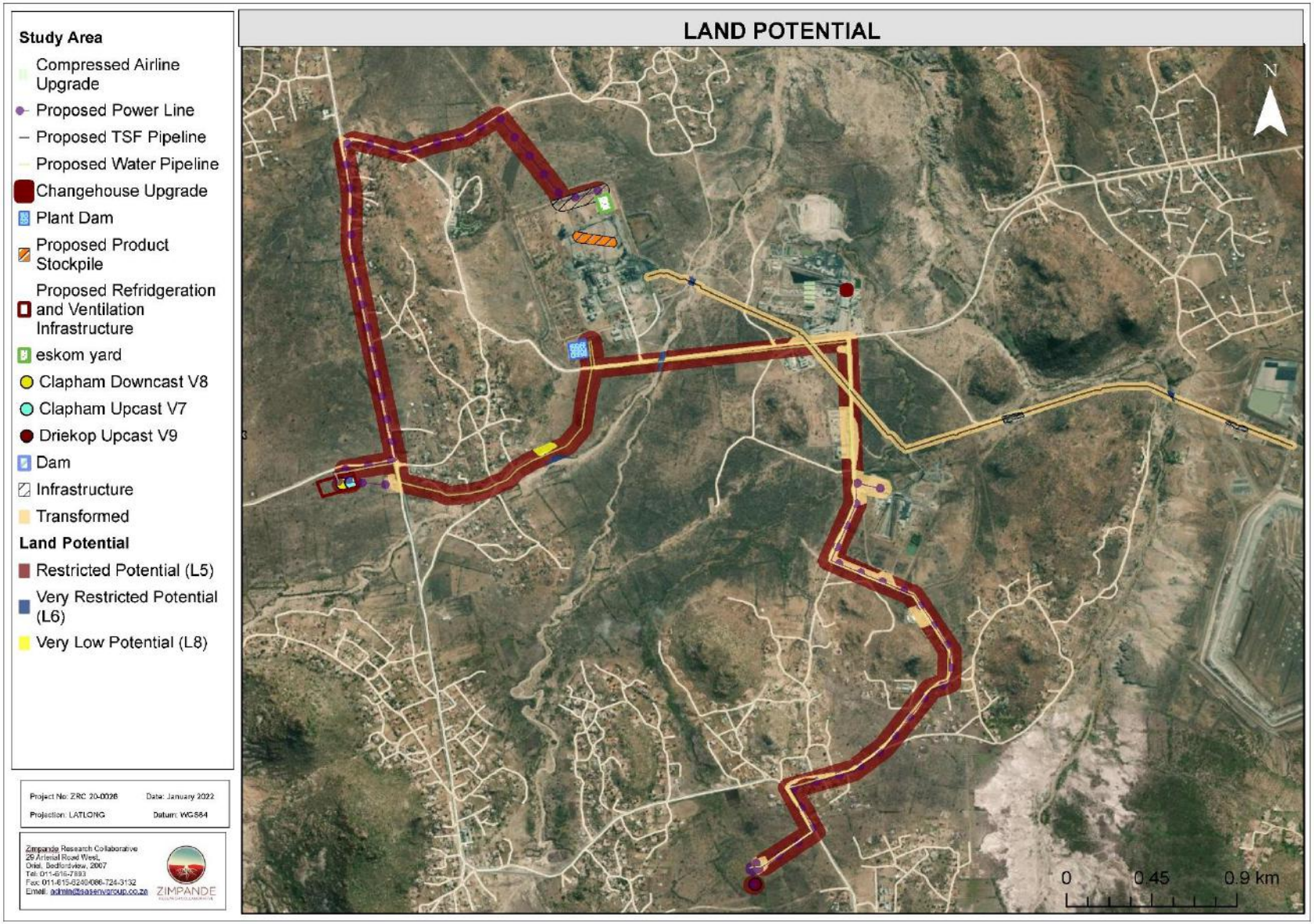

Figure 11: Map depicting agricultural sensitivity of soils occurring within the study area.

Table 10: Summary discussion of the watercourse (Class V) land capability class

<table>
<tr><th colspan="5">Land Capability: Watercourse (Class V)</th></tr>
<tr><td colspan="5">  </td></tr>
<tr><td>Terrain Morphological Unit (TMU)</td><td colspan="2">Relatively flat to moderately sloping land of <1.5% slope</td><td>Photograph notes</td><td>View of the bleached sandy alluvial soil material associated with the watercourse</td></tr>
<tr><td>Soil Form(s)</td><td colspan="2">alluvial</td><td>Areal Extent</td><td>1.51 ha which constitutes 1.8% of the study area</td></tr>
<tr><td>Physical Limitations</td><td colspan="2">Soils are very sandy and subject to wind and water erosion and often shallow in depth.</td><td colspan="2" rowspan="2">Land Capability
The identified soils are of poor (Class V) land capability due to wetness limitations during the good rainy seasons. These soils are associated with watercourse features in the arid environments and cultivation on these soils would prove impractical.</td></tr>
<tr><td>Land Potential</td><td colspan="2">(L6) Very Restricted Potential: Due to association with the watercourse</td></tr>
<tr><td>Overall impact significance prior to mitigation</td><td>M</td><td rowspan="2">The overall impact of the proposed activity/infrastructure changes on land capability and land potential is anticipated to be Moderate (M) without mitigation measures in place and Low (L) post mitigation. This is due to the inherently poor land capability of the identified dominant soil forms. The proposed proposed activity/infrastructure changes in areas with this soil type.</td><td colspan="2" rowspan="2">Business case, Conclusion and Mitigation Requirements:
While these soils are not considered prime agricultural production soils, they are crucial for freshwater systems in the area. Thus, avoidance of these soils is deemed imperative in line with the National Water Act No. 36 of 1998.</td></tr>
<tr><td>Overall impact significance post to mitigation</td><td>L</td></tr>
</table>

Table 11: Summary discussion of the Grazing (Class VI) land capability class

<table>
<tr><th colspan="5">Land Capability: Grazing (Class VI) and Restricted land potential</th></tr>
<tr><td colspan="5">  </td></tr>
<tr><td>Terrain Morphological Unit (TMU)</td><td colspan="2">Relatively flat landscapes of < 0.2% slope gradient</td><td>Photograph notes</td><td>View of the sandy topsoil, pedocutanic and soft carbonate soil horizons associated with soil forms occurring within the soil profile of the identified soil forms.</td></tr>
<tr><td>Soil Form(s)</td><td colspan="2">Spionberg/Valsrivier and Brandvlei</td><td>Area Extent</td><td>70.4 ha which constitutes 81% of the study area</td></tr>
<tr><td>Physical Limitations</td><td colspan="2">Spionberg/Valsrivier are characterized by high clay content in the subsoil and strong structure and Brandvlei soils are characterized by limited rooting depth (<60 cm).</td><td colspan="2" rowspan="2">Land Capability and Land Potential
Land has very serious permanent limitations that restrict the choice of alternative crops or the intensity of crop production to a great extent.</td></tr>
<tr><td>Land Potential</td><td colspan="2">L5 (Restricted Potential): Regular and/or moderate to severe limitations due to soil, slope, temperature, or rainfall.</td></tr>
<tr><td>Overall impact significance prior to mitigation</td><td>M</td><td rowspan="2">The overall impact of the proposed development on land capability and land potential is anticipated to be Medium without mitigation measures and Low with mitigation measures in place. Due to the inherently low land capability of the identified dominant soil forms. The proposed developments will result in a permanent change of land use. If this area is clearly demarcated the impact could potentially be reduced to low since the adjacent area could potentially be used as grazing land by subsistence farmers in the neighbouring communities.</td><td colspan="2" rowspan="2">Business case, Conclusion and Mitigation Requirements:
The identified soils are generally not considered significant in terms of agricultural productivity. Should agricultural production be considered intense management practices have to be applied, which are usually costly and not economical based on the expected yields from these soils. This is exacerbated by the climate of the area. However, plant and animal species habitat is likely to be affected. These soils are best suited for grazing, rangeland and wildlife. The proposed developments are viable on these soils considering the agricultural potential of these soils. Mitigation measures should this put in place to minimise further disruption of other adjacent soils which can potentially be used for grazing, rangeland and wildlife.</td></tr>
<tr><td>Overall impact significance post mitigation</td><td>L</td></tr>
</table>

Table 12: Summary discussion of the Wilderness (Class VII) land capability class

<table>
<tr><th colspan="5">Land Capability: Grazing (Class VII) and Very Low land potential.</th></tr>
<tr><td colspan="5">  </td></tr>
<tr><td colspan="2">Terrain Morphological Unit (TMU)</td><td>Gently sloping landscapes of < 0.5% slope gradient</td><td>Photograph notes</td><td>View of the shallow soil horizon, rock outcrop and physically disturbed soils associated with the Mispah and Witbank soil forms.</td></tr>
<tr><td colspan="2">Soil Form(s)</td><td>Mispah (Lithic soil forms)</td><td>Area Extent</td><td>14 ha which constitutes 16.5% of the total study area.</td></tr>
<tr><td colspan="2">Physical Limitations</td><td>Lithic soils are normally referred to as young soils due to their shallow effective rooting depth (<20 cm) which is the primary limitation of this soil group of land capability.</td><td colspan="2" rowspan="2">Land Capability and Land Potential
The Lithic soils (Mispah) are also considered to be of poor (Class VI) land capability and are not suitable for arable agriculture. These soils are therefore considered to have low land potential. Low land potential has permanent limitations that exclude it from commercial plant production and the use thereof is limited to wildlife, recreation, water provision and aesthetic qualities.</td></tr>
<tr><td colspan="2">Land Potential</td><td>L8 (Very low potential): Very severe limitations due to soil, slope, temperature or rainfall. Non-arable.</td></tr>
<tr><td>Overall impact significance prior to mitigation</td><td>M</td><td rowspan="2">The overall impact of the proposed developments on the land capability of these soils is anticipated to be medium with mitigation due to their inherently poor land capability. If this area is clearly demarcated the impact could potentially be reduced to low since the adjacent area could potentially be used as grazing land by subsistence farmers in the neighbouring communities.</td><td colspan="2" rowspan="2">Business case, Conclusion and Mitigation Requirements:

The identified Mispah soils are generally not considered to be of significant agricultural productivity. These soils, at best are suited for grazing, recreation and wildlife. The proposed developments are viable on these soils considering the extent of the area that will be disturbed and agricultural potential of these soils. Mitigation measures should be put in place to minimise further disruption of other adjacent soils which can potentially be used for grazing and other activities.</td></tr>
<tr><td>Overall impact significance post mitigation</td><td>L</td></tr>
</table>

5. IMPACT ASSESSMENT AND MITIGATION MEASURES

This section presents the significance of potential impacts on the identified soil resources associated with the proposed developments. In addition, it also indicates the required mitigatory measures needed to minimise the perceived impacts associated with the proposed development and presents an assessment of the significance of the impacts taking into consideration the available mitigatory measures and assuming that they are fully implemented. The description of the impact significance and ratings are presented on Table 13 and Table 14.

Table 13: Description of the impact significance in relation to the to the proposed activities and developments within the study area.

PART D: INTERPRETATION OF SIGNIFICANCE	
Significance	**Decision guideline**
Very High	Potential fatal flaw unless mitigated to lower significance.
High	It must have an influence on the decision. Substantial mitigation will be required.
Medium	It should have an influence on the decision. Mitigation will be required.
Low	Unlikely that it will have a real influence on the decision. Limited mitigation is likely required.
Very Low	It will not have an influence on the decision. Does not require any mitigation
Insignificant	Inconsequential, not requiring any consideration.

Table 14: : Description of terms used in the impact assessment rating for the proposed activities and developments within the study area.

PART A: DEFINITIONS AND CRITERIA*		
Definition of SIGNIFICANCE		**Significance = consequence x probability**
Definition of CONSEQUENCE		**Consequence is a function of intensity, spatial extent and duration**
Criteria for ranking of the INTENSITY of environmental impacts	**VH**	Severe change, disturbance or degradation. Associated with severe consequences. May result in severe illness, injury or death. Targets, limits and thresholds of concern continually exceeded. Substantial intervention will be required. Vigorous/widespread community mobilization against project can be expected. May result in legal action if impact occurs.
	H	Prominent change, disturbance or degradation. Associated with real and substantial consequences. May result in illness or injury. Targets, limits and thresholds of concern regularly exceeded. Will definitely require intervention. Threats of community action. Regular complaints can be expected when the impact takes place.
	M	Moderate change, disturbance or discomfort. Associated with real but not substantial consequences. Targets, limits and thresholds of concern may occasionally be exceeded. Likely to require some intervention. Occasional complaints can be expected.
	L	Minor (Slight) change, disturbance or nuisance. Associated with minor consequences or deterioration. Targets, limits and thresholds of concern rarely exceeded. Require only minor interventions or clean-up actions. Sporadic complaints could be expected.
	VL	Negligible change, disturbance or nuisance. Associated with very minor consequences or deterioration. Targets, limits and thresholds of concern never exceeded. No interventions or clean-up actions required. No complaints anticipated.

	VL+	Negligible change or improvement. Almost no benefits. Change not measurable/will remain in the current range.
	L+	Minor change or improvement. Minor benefits. Change not measurable/will remain in the current range. Few people will experience benefits.
	M+	Moderate change or improvement. Real but not substantial benefits. Will be within or marginally better than the current conditions. Small number of people will experience benefits.
	H+	Prominent change or improvement. Real and substantial benefits. Will be better than current conditions. Many people will experience benefits. General community support.
	VH+	Substantial, large-scale change or improvement. Considerable and widespread benefit. Will be much better than the current conditions. Favourable publicity and/or widespread support expected.
Criteria for ranking the DURATION of impacts	**VL**	Very short, always less than a year. Quickly reversible
	L	Short-term, occurs for more than 1 but less than 5 years. Reversible over time.
	M	Medium-term, 5 to 10 years.
	H	Long term, between 10 and 20 years. (Likely to cease at the end of the operational life of the activity)
	VH	Very long, permanent, +20 years (Irreversible. Beyond closure)
Criteria for ranking the EXTENT of impacts	**VL**	A part of the site/property.
	L	Whole site.
	M	Beyond the site boundary, affecting immediate neighbours
	H	Local area, extending far beyond site boundary.
	VH	Regional/National

5.1 Activities

Proposed Activity Description:

The proposed additional surface infrastructure comprises the following:

- The establishment of two additional ventilation shafts;
- The upgrade to refrigeration and ventilation infrastructure at existing ventilation shafts.
- The establishment of additional water pipelines to support the additional ventilation shafts;
- The expansion and establishment of additional power supply and distribution infrastructure in support of the establishment of additional ventilation shaft and upgrades to existing ventilation shafts);
- The establishment of a product stockpile within the existing footprint of the Concentrator Plant;
- The establishment of an additional pipeline to the approved Tailings Storage Facility (TSF); and
- Structural upgrades of the existing change house and compressed airline at the Clapham Shaft Complex.

The impact assessment will be divided into line infrastructure (pipelines, powerlines and conveyor lines) and built infrastructure (ventilation shaft, change house, ventilation and refrigeration infrastructure.

The soils are anticipated to be exposed to erosion, dust emission, and potential soil contamination impacts during the construction phase of the study area; and these impacts may persist for the duration of the operational phase if not mitigated adequately. The activities associated with the proposed developments are presented on Table 15.

The impact assessment rating is applicable to the following activities:

Table 15: Activities associated with study area during different phases

Phase	Activities
Pre- Construction Phase	Planning and design of the footprint areas.
	Preparation for the construction activities
construction	Clearing of the footprint area associated for the proposed developments
	Soil striping
	Construction of various infrastructure
Operational	Operation of mining related activities

5.1.1 Soil Erosion

Soil erosion is largely dependent on land use and soil management and is generally accelerated by anthropogenic activities. In the absence of detailed South African guidelines on erosion classification, the erosion potential and interpretation are based on field observations as well as observed soil profile characteristics. In general, soils with high clay content have a high-water retention capacity, thus less prone to erosion in comparison to sandy textured soils, which in contrast are more susceptible to erosion.

The proposed development is located on a relatively flat to gently sloping terrain, which decreases the erosion hazard. However, the sandy nature of the topsoil with little organic carbon content and the sparse vegetation cover makes the identified soils highly susceptible to erosion. Their susceptibility to erosion is likely to increase once the land is cleared for excavation, and the soils will inevitably be exposed to wind and stormwater. The overall soil erosion impact is therefore anticipated to be Medium during the pre-construction, construction and operational phases. Hence mitigation measures will be required. Post mitigation measures the impact is anticipated to be Low during the pre-construction and construction phases and very low during the operational phases.

Refer to Table 16 and 18 for the different impact significance ratings on soil erosion before mitigation for the linear and surface infrastructure respectively and Table 17 and 19 for impact significance ratings on soil erosion post mitigation for the linear and surface infrastructure respectively.

Aspects and activities register

Pre-Construction	Construction	Operational
Potential poor planning leading to excessive erosion outside the study area demarcations.	Site clearing, removal of vegetation, and associated disturbances to soils, leading to, increased runoff, erosion and consequent loss of land capability in cleared areas.	Constant disturbances of soils, resulting in risk of erosion
	Potential frequent movement of digging machinery within lose and exposed soils, leading to excessive erosion	

Table 16: Summary of the impact significance on soil erosion for the line infrastructure.

Activity	Probability	Intensity	Spatial extent	Duration	Consequence	Significance
Pre-Construction	VH	M	L	L	**Medium**	**Medium**
Construction	VH	M	L	H	**Medium**	**Medium**
Operational	H	M	L	M	**Medium**	**Medium**

Table 17: Summary of the impact significance on soil erosion for the line infrastructure post mitigation.

Activity	Probability	Intensity	Spatial extent	Duration	Consequence	Significance
Pre-Construction	H	L	L	L	**Low**	**Low**
Construction	H	L	L	M	**Low**	**Low**
Operational	M	L	L	L	**Low**	**Very Low**

Table 18: Summary of the impact significance on soil erosion for the surface infrastructure.

Activity	Probability	Intensity	Spatial extent	Duration	Consequence	Significance
Pre-Construction	VH	M	L	L	**Medium**	**Medium**
Construction	H	M	L	H	**Medium**	**Medium**
Operational	M	M	L	M	**Medium**	**Medium**

Table 19: Summary of the impact significance on soil erosion for the surface infrastructure post mitigation.

Activity	Probability	Intensity	Spatial extent	Duration	Consequence	Significance
Pre-Construction	H	L	VL	L	**Low**	**Low**
Construction	H	L	VL	L	**Low**	**Low**
Operational	M	L	VL	M	**Low**	**Very Low**

5.1.2 Potential Soil Compaction

Heavy equipment traffic during construction and activities is anticipated to cause soil compaction. The severity of this impact is likely to be significant for most of the soils due to amount of disturbance that could occur due to the clayey texture of the subsoils. The impact significance can be reduced significantly, should the proposed activities be restricted to access roads, vehicle hard stand areas and equipment and machinery laydown areas. Soil compaction will potentially lead to:

- Increased bulk density and soil strength, reduced aeration and lower infiltration rate

- Destroyed soil structure, causing it to become more massive with fewer natural voids with a high possibility of soil crusting.
- Soil biodiversity is also influenced by reduced soil aeration. Severe soil compaction may cause reduced microbial biomass. Soil compaction may not influence the quantity, but the distribution of macro fauna that is vital for soil structure including earthworms due to reduction in large pores.

The overall soil compaction impact is therefore anticipated to be Medium during the pre-construction construction and operational phases. Hence it should have an influence on the decision and mitigation measures will be required. Post mitigation measures the significant impacts are anticipated to be Low during the pre-construction and construction phases and Very Low during the operational phase.

Refer to Table 20 and 22 for the different impact significance ratings on potential soil compaction before mitigation for the linear and surface infrastructure respectively and Table 21 and 23 for impact significance ratings on potential soil compaction post mitigation for the linear and surface infrastructure respectively.

Aspects and activities register

Pre-Construction	Construction	Operational
Potential poor planning leading to excessive or unnecessary placement of infrastructure outside the study area or the demarcated infrastructure areas leading to increased soils compaction.	Site clearing and associated disturbances to soils, leading to, increased runoff, soil compaction and consequent loss of land capability in cleared areas.	Constant disturbances of soils, resulting in risk of compaction
	Potential frequent movement of digging machinery and construction vehicles within lose and exposed soils, leading to excessive soil compaction	

Table 20: Summary of the impact significance on soil compaction for the line infrastructure.

Activity	Probability	Intensity	Spatial extent	Duration	Consequence	Significance
Pre-Construction	VH	M	M	L	**Medium**	**Medium**
Construction	VH	M	L	M	**Medium**	**Medium**
Operational	H	M	L	M	**Medium**	**Medium**

Table 21: Summary of the impact significance on soil compaction for the line infrastructure post mitigation.

Activity	Probability	Intensity	Spatial extent	Duration	Consequence	Significance
Pre-Construction	H	L	L	L	**Low**	**Low**
Construction	H	L	L	M	**Low**	**Low**
Operational	M	L	L	L	**Low**	**Very Low**

Table 22: Summary of the impact significance on soil compaction for the surface infrastructure

Activity	Probability	Intensity	Spatial extent	Duration	Consequence	Significance

Pre-Construction	H	M	L	L	**Medium**	**Medium**
Construction	H	H	L	M	**Medium**	**Medium**
Operational	H	M	L	M	**Medium**	**Medium**

Table 23: Summary of the impact significance on soil compaction for the surface infrastructure post mitigation.

Activity	**Probability**	**Intensity**	**Spatial extent**	**Duration**	**Consequence**	**Significance**
Pre-Construction	H	L	VL	L	**Low**	**Low**
Construction	M	M	VL	M	**Low**	**Low**
Operational	M	L	VL	M	**Low**	**Very Low**

5.1.3 Potential Soil Contamination

Contamination sources are mostly unpredictable and often occur as incidental spills or leaks during both the construction and operational phase. Thus, all the identified soils are considered equally predisposed to potential contamination. The significance of contamination is largely dependent on the nature, volume and/or concentration of the contaminant of concern as well as the rate at which contaminants are transported by water in the soil. Therefore, strict waste management protocols as well as product stockpile management and activity specific Environmental Management Programme (EMP) and monitoring guidelines should be adhered to during the construction and operational activities. If the management protocols are not well managed this will more likely lead to:

- Contaminants leaching into the soil and thus potentially rendering the soil sterile. reducing the yield potential of soils.
- Potential reduction of water quality used for irrigation and for livestock use.

The overall soil contamination impact is therefore anticipated to be Medium during the pre-construction, construction and operational phases. Hence it should have an influence on the decision and mitigation measures will be required. Post mitigation measures the significant impacts are anticipated to be Very Low during the pre-construction, construction and operational phases.

Refer to Table 24 and 26 for the different impact significance ratings before on potential soil contamination mitigation for the linear and surface infrastructure respectively and Table 25 and 27 for impact significance ratings on potential soil contamination post mitigation for the linear and surface infrastructure respectively.

Aspects and activities register

Pre-Construction	Construction	Operational
Potential poor planning leading to excessive or unnecessary pollution of soils outside the study area demarcations.	Spillage of petroleum hydrocarbons during construction of associated infrastructure	Leaching of hydrocarbons chemicals into the soils, leading to alteration of the soil chemical status as well as contamination of ground water

Pre-Construction	Construction	Operational
	Disposal of hazardous and non-hazardous waste, including waste material spills and refuse deposits into the soil.	Disposal of hazardous and non-hazardous waste, including waste material spills and refuse deposits into the soil.

Table 24: Summary of the impact significance for soil contamination for the line infrastructure.

Activity	Probability	Intensity	Spatial extent	Duration	Consequence	Significance
Pre-Construction	H	L	M	M	Medium	Medium
Construction	H	M	M	M	Medium	Medium
Operational	M	M	M	M	Medium	Medium

Table 25: Summary of the impact significance for soil contamination for the line infrastructure post mitigation.

Activity	Probability	Intensity	Spatial extent	Duration	Consequence	Significance
Pre-Construction	M	VL	L	L	Very Low	Very Low
Construction	M	L	L	L	Low	Very Low
Operational	M	VL	L	L	Very Low	Very Low

Table 26: Summary of the impact significance for soil contamination for the built infrastructure.

Activity	Probability	Intensity	Spatial extent	Duration	Consequence	Significance
Pre-Construction	H	L	M	M	Medium	Medium
Construction	H	M	M	M	Medium	Medium
Operational	M	M	M	M	Medium	Medium

Table 27: Summary of the impact significance for soil contamination for the built infrastructure post mitigation.

Activity	Probability	Intensity	Spatial extent	Duration	Consequence	Significance
Pre-Construction	M	VL	L	L	Very Low	Very Low
Construction	M	L	L	L	Low	Very Low
Operational	M	VL	L	L	Very Low	Very Low

5.1.4 Loss of Agricultural Land Capability

The impact on soil land capability is therefore anticipated to be Low during the pre-construction, construction and Very Low during the operational phase. Hence limited mitigation is likely to be required. This is because the dominant soils are not considered ideal for cultivation due to their inherent poor drainage characteristics, shallow rooting depth and limited nutrient retention due to the bleached topsoils. Post mitigation measures the impact significance ratings are anticipated to be Very Low during the pre-construction phase, Low during the construction phase and Insignificant during the operational phase. Refer to Table 28 for the different impact significance ratings on loss of agricultural land capability before

mitigation and Table 29 for impact significance ratings on loss of agricultural land capability post mitigation.

Table 28: Summary of the impact significance for soil land capability.

Activity	Probability	Intensity	Spatial extent	Duration	Consequence	Significance
Pre-Construction	H	L	L	L	Low	Low
Construction	VH	L	L	L	Low	Low
Operational	M	L	L	L	Low	Very Low

Table 29: Summary of the impact significance for soil land capability post mitigation.

Activity	Probability	Intensity	Spatial extent	Duration	Consequence	Significance
Pre-Construction	M	VL	L	L	Very Low	Very Low
Construction	H	L	L	L	Low	Low
Operational	L	VL	L	L	Very Low	Insignificant

5.1.5 Cumulative Impact

The cumulative loss from a soil and land capability point of view is not anticipated to be significant as the dominant soils within each footprint area are not considered ideal for cultivation. In addition, the impact on the soils from each footprint area will be localised because each ventilation shaft has a possible footprint area of less than 0.5 hectare, with the longest distance for water pipelines and power transmission lines being 5.2 km. It should also be noted that large portions of proposed line infrastructure (i.e., water pipeline) are located within the road reserves where some impact has occurred as a result of edge effects. The stockpile area is already located under the infrastructural area and thus not anticipated to cause any significant impact.

The study area is surrounded by mining related activities, residential areas, as well as wilderness areas and is isolated from any big scale agricultural activities in the area. The mining related activities dominate a large portion of the study area and thus has caused significant impact on the soils. Hence, the development of this area is not anticipated to cause a significant cumulative impact since this area is not under current cultivation and the extent of the area to be impacted is limited. The cumulative impact on the local and regional scale is considered medium as the dominant soils are not sensitive from a soil and land capability point of view. However, soils are scarce non-renewable resources which need to be protected, conserved and managed in compliance with the CARA, 1983 (Act No. 43 of 1983).

5.2 Integrated Mitigation Measures

Based on the findings of the soil, land use and land capability assessment, mitigation measures have been developed to minimise the impact on the soil resources of the area, should the proposed project proceed:

5.2.1 Soil Erosion

- The footprint of the proposed development and construction activities should be clearly demarcated to restrict vegetation clearing activities within the infrastructure footprint as far as practically possible;
- Bare soils within the access roads can be regularly dampened with water to suppress dust during the construction phase, especially when strong wind conditions are predicted according to the local weather forecast;
- All disturbed areas adjacent to the proposed development areas should be re-vegetated with an indigenous grass mix, if necessary, to re-establish a protective cover, to minimise soil erosion and dust emission;

5.2.2 Soil compaction Management

- Compacted soils adjacent to the proposed developments during construction should be lightly ripped to at least 25 cm below ground surface to alleviate compaction;
- Soil Compaction is usually greatest when soils are moist, so soils should be stripped when moisture content is as low as possible. If they have to be moved when wet, truck and shovel should be used as bowlscrapers create excessive compaction when moving wet soils.

5.2.3 Soil Contamination Management

- Contamination prevention measures should be addressed in the Environmental Management Programme (EMP) for the proposed development, and this should be implemented and made available and accessible at all times to the contractors and construction crew conducting the works on site for reference;
- Burying of any waste including rubble, domestic waste, empty containers on the site should be strictly prohibited and all construction rubble waste must be removed to an approved disposal site;
- A spill prevention and emergency spill response plan, as well as dust suppression, and fire prevention plans should also be compiled to guide the construction works; and
- An emergency response contingency plan should be put in place to address clean-up measures should a spill and/or a leak occur, as well as preventative measures to prevent contamination.

5.2.4 Loss of Land Capability Management

- Close supervision and monitoring of the stripping process is required to ensure that soils are stripped correctly and backfilled after the laying down of water pipelines.
- Revegetate the disturbed soils with an indigenous grass mix, to re-establish a protective cover, in order to minimise soil erosion and dust emissions; and
- The footprint areas should be lightly ripped to alleviate compaction.

6. CONCLUSION

The Zimpande Research Collaborative (ZRC) was appointed to conduct a soil, land use, land capability and agricultural potential assessment as part of the environmental impact assessment and authorisation process for the proposed ventilation shafts, ore stockpile, power transmission lines and water pipeline. The proposed development footprint area will hereafter be collectively referred to as the "study area" unless referring to individual infrastructure (i.e., ventilation shaft, stockpile area, power transmission lines and water pipelines etc.).

High agricultural potential land is a scarce non-renewable resource, which necessitates an Agricultural Potential assessment prior to land development, particularly for purposes other than agricultural land use, as per the Conservation of Agricultural Resources Act (CARA), 1983 (Act No. 43 of 1983). High potential agricultural land is defined as land having ''the soil and terrain quality, growing season and adequate available moisture supply to sustain crop production when treated and managed according to best possible farming practices" (Land Capability report ARC, 2006). Land Capability Classification is measured on a scale of I to VIII, with the classes of I to III considered as prime agricultural soils and classes V to VIII not suitable for cultivation.

Based on the observations during the site assessment, the dominant land uses within the study area and the surroundings are mining related activities, with residential areas and wilderness/wildlife being the subdominant land uses. No agricultural activities were observed in the immediate vicinity of the study area.

A total of four (4) soil forms were identified within the study area and these include Spionberg/Valsrivier, Brandvlei, Mispah and Witbank. The agricultural potential of these soil forms ranges from restricted to very low, thus rendering the study area to marginally suitable for cultivated agriculture and under intensive management. The poor agricultural potential of these soil forms can be attributed to their inherent characteristics which include but not limited to:

- Poor drainage characteristics;
- Shallow rooting depth due to high clay content in the B horizon;
- Inadequate moisture;
- Bleached topsoils which lack nutrient retention capacity to support optimum growth and production; and
- Disturbed soils due to anthropogenic influences.

The soils of the Spionberg/Valsrivier are associated with poor physical properties induced by high clay content and very strong structure. The high clay content may effectively reduce water infiltration and thus these soils are more prone to waterlogging conditions as well as intensified runoff during high intensity rainfall. This intensified runoff makes the soils more prone to erosion and thus the formation of gullies which are not favourable for most cultivated crops. The strongly developed structure of the soils may impede root growth and thus limit the area to mostly grazing and/or forestry capability. Nutrient uptake by plants may be limited as these soils tend to hold nutrients tightly to the soil colloids due to the high cation exchange capacity (CEC) caused by high clay content, meaning that more nutrients are held on the soil and are not readily available for plant uptake. Nonetheless, should the soils be cultivated, intensive management practices will have to be implemented.

Brandvlei soil types are associated with the accumulation of calcium carbonate over a long period of time. The pH of these soils increases with depth, typically approaching 8 to 8.5 in the sub-soil. This can potentially induce high capacity for metal cations retention, in so doing potentially reducing agricultural productivity through the deficiency of phosphorus and certain trace elements. Calcic soils are typically low in organic matter due to spatially scattered vegetation in the landscape and rapid decomposition of organic matter in arid areas in which they occur.

Mispah soil types are soils associated with poor physical properties for plant root system penetration and water infiltration, due to the limiting impeding layer of the underlying parent material. These Mispah soils are also highly susceptible to erosion due to their poor hydraulic conductivity, thus not suitable for commercial agricultural cultivation.

Witbank soils are considered of very low agricultural potential due to the soils having been subjected to physical disturbance because of human interventions. Such interventions include transportation and deposition of the earth material containing soil. As a result, these soils are unable to support agricultural production unless significant amelioration and rehabilitation takes place .

Table A below represents the soil forms identified within the study area as well as their diagnostic horizons, respectively.

Table A: Identified soil forms within the study area and their respective land capability and land potential.

Soil Form	Land capability	Land Potential	Area (ha)	Percentage
Alluvial Watercourse	Class V	Restricted Potential (L6)	1.51	1.8
Spionsberg/Valsrivier	Class VI	Restricted Potential (L5)	69.21	80.4
Brandvlei	Class VI	Restricted Potential (L5)	3.19	1.4
Mispah	Class VIII	Very Low Potential (L8)	14.64	16.5
Total enclosed			**86.12**	**100**

The findings of this assessment suggest that the relevant soil and climatic limiting factors within the study area for land capability and land use potential for agriculture include the following:

- Moderately restricted growing season due to low temperatures, frost and/or moisture stress. Suitable crops may be grown at risk of some yield loss according to the Climate Capability Classification by Scotney *et al*., 1987;
- High clay content of the Spionberg/Valsrivier soil forms affecting rooting depth and moisture content and low nutrient content of Brandvlei soil form;
- Shallow effective rooting depth due to shallow indurated bedrock of the Mispah and Brandvlei soil forms. As such, these soils are not considered able to contribute significantly to agricultural production on a national or provincial scale;
- Susceptibility to erosion of Mispah soils form; and
- Lack of soil medium for plants and crop growth in rocky soils, areas associated with mine infrastructure and no production within surface water areas.

The cumulative loss from a soil and land capability point of view is not anticipated to be significant as the dominant soils within the project footprint area are not considered ideal for cultivation. In addition, the impact on the soils from each footprint area will be localised as each ventilation shaft has a possible footprint area of less than 0.5 hectare, with the longest distance for the proposed water pipelines and power transmission lines being 5.2 km. It should

also be noted that large portions of proposed linear infrastructure (i.e. water pipelines) are located within the road reserves where some impact as a result of edge effects has occurred. The stockpile area is already located under the existing infrastructural area and thus not anticipated to cause any significant impact. The study area is surrounded by residential areas as well as wilderness and is isolated from any large-scale agricultural activities in the area. The development of this area is not anticipated to cause a significant cumulative impact since this area is not under current cultivation and the extent of the area to be impacted is limited. The cumulative impact on the local and regional scale is considered medium-low as the dominant soils are not of high importance from a soil and land capability point of view. However, soil is a scarce, non-renewable resource which need to be protected, conserved and managed in compliance with the CARA, 1983 (Act No. 43 of 1983).

The screening tool analysis was conducted, which presented the findings as the impact on agricultural resources being of a High sensitivity rating. However, the screening tool analysis was found to be in contrast with the filed assessment results. The field assessment results indicated that the soils within the footprint areas to be of low agricultural potential, with no prior cultivation for the past 5 years.

Key mitigation measures to minimise impacts on the soil regime include but are not limited to:

- The project operations be kept within the demarcated footprint areas which must be well defined;
- Bare soils within the access roads should be regularly dampened with water to suppress dust during the construction phase, especially when strong wind conditions are predicted according to the local weather forecast;
- A soil monitoring programme should be initiated within the access roads and adjacent areas to ascertain whether the dust suppression has an impact on the soil chemistry; and
- Soil Compaction is usually greatest when soils are moist. Therefore, soils should be stripped when moisture content is as low as possible. If soil must be moved when wet, truck and shovel should be used as bowlscrapers create excessive compaction when moving wet soils.

From a soil and land capability point of view, this project is not regarded as being fatally flawed due to various inherent soil constraints for commercial agricultural production, however mitigation measures and recommendations outlined in this document need to be strongly considered and implemented accordingly in efforts to conserve soil resources.

7. REFERENCES

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APPENDIX A: ASSESSMENT METHODOLOGY

Desktop Screening

Prior to commencement of the field assessment, a background study, including a literature review, was conducted in order to collect the pre-determined soil and land capability data in the vicinity of the investigated area Various data sources including but not limited to the Agricultural Geo-Referenced Information System (AGIS) and other sources as listed under references were used for the assessment.

Soil Classification and Sampling

A soil survey was conducted in November 2020 by a qualified soil specialist, at which time the identified soils within the study area were classified into soil forms according to the Soil Classification Working Group for South Africa (2018). Subsurface soil observations were made using a manual hand auger in order to assess individual soil profiles, which entailed evaluating physical soil properties and prevailing limitations to various land uses.

Land Capability Classification

Agricultural potential is directly related to Land Capability, as measured on a scale of I to VIII, as presented in Table **A1** below; with Classes I to III classified as prime agricultural land that is well suitable for annual cultivated crops. Whereas, Class IV soils may be cultivated under certain circumstances and management practices, whereas Land Classes V to VIII are not suitable to cultivation. Furthermore, the climate capability is also measured on a scale of 1 to 8, as illustrated in Table **A2** below. The land capability rating is therefore adjusted accordingly, depending on the prevailing climatic conditions as indicated by the respective climate capability rating. The anticipated impacts of the proposed land use on soil and land capability were assessed in order to inform the necessary mitigation measures.

Table A1: Land Capability Classification (Smith, 2006)

Land Capability Class	Increased Intensity of Use									Land Capability Groups
I	W	F	LG	MG	IG	LC	MC	IC	VIC	**Arable land**
II	W	F	LG	MG	IG	LC	MC	IC		
III	W	F	LG	MG	IG	LC	MC	IC		
IV	W	F	LG	MG	IG	LC				
V	W		LG	MG						**Grazing land**
VI	W	F	LG	MG						
VII	W	F	LG							
VIII	W									**Wildlife**

W- Wildlife	MG- Moderate grazing	MC- Moderate cultivation
F- Forestry	IG- Intensive grazing	IC- Intensive cultivation
LG- Light grazing	LC- Light cultivation	VIC- Very intensive cultivation

Table A2: Climate Capability Classification (Scotney et al., 1987)

Climate Capability Class	Limitation Rating	Description
C1	None to slight	Local climate is favourable for good yield for a wide range of adapted crops throughout the year.
C2	Slight	Local climate is favourable for good yield for a wide range of adapted crops and a year round growing season. Moisture stress and lower temperatures increase risk and decrease yields relative to C1.
C3	Slight to moderate	Slightly restricted growing season due to the occurrence of low temperatures and frost. Good yield potential for a moderate range of adapted crops.
C4	Moderate	Moderately restricted growing season due to low temperatures and severe frost. Good yield potential for a moderate range of adapted crops but planting date options more limited than C3.
C5	Moderate to severe	Moderately restricted growing season due to low temperatures, frost and/or moisture stress. Suitable crops may be grown at risk of some yield loss.
C6	Severe	Moderately restricted growing season due to low temperatures, frost and/or moisture stress. Limited suitable crops for which frequently experience yield loss.
C7	Severe to very severe	Severely restricted choice of crops due to heat, cold and/or moisture stress.
C8	Very severe	Very severely restricted choice of crops due to heat and moisture stress. Suitable crops at high risk of yield loss.

The land potential assessment entails the combination of climatic, slope and soil condition characteristics to determine the agricultural land potential of the investigated area. The classification of land potential and knowledge of the geographical distribution within an area of interest. This is of importance for making an informed decision about land use. **Table A3** below presents the land potential classes, whilst Table A4 presents description thereof, according to Guy and Smith (1998).

Table A3: Land Potential Classes (Guy and Smith, 1998)

Land Capability Class	Climate Capability Class							
	C1	C2	C3	C4	C5	C6	C7	C8
I	L1	L1	L2	L2	L3	L3	L4	L4
II	L1	L2	L2	L3	L3	L4	L4	L5
III	L2	L2	L3	L3	L4	L4	L5	L6
IV	L2	L3	L3	L4	L4	L5	L5	L6
V	Vlei	Vlei	Vlei	Vlei	Vlei	Vlei	Vlei	Vlei
VI	L4	L4	L5	L5	L5	L6	L6	L7
VII	L5	L5	L6	L6	L7	L7	L7	L8
VIII	L6	L6	L7	L7	L8	L8	L8	L8

Table A4: The Land Capability Classes Description (Guy and Smith, 1998)

Land Potential	Description of Land Potential Class
L1	**Very high potential:** No limitations. Appropriate contour protection must be implemented and inspected.
L2	**High potential:** Very infrequent and/or minor limitations due to soil, slope, temperatures or rainfall. Appropriate contour protection must be implemented and inspected.
L3	**Good potential:** Infrequent and/or moderate limitations due to soil, slope, temperatures or rainfall. Appropriate contour protection must be implemented and inspected.
L4	**Moderate potential:** Moderately regular and/or severe to moderate limitations due to soil, slope, temperature or rainfall. Appropriate permission is required before ploughing virgin land.
L5	**Restricted potential:** Regular and/or moderate to severe limitations due to soil, slope, temperature or rainfall.
L6	**Very restricted potential:** Regular and/or severe limitations due to soil, slope, temperature or rainfall. Non-arable.
L7	**Low potential:** Severe limitations due to soil, slope, temperature or rainfall. Non-arable.
L8	**Very low potential:** Very severe limitations due to soil, slope, temperature or rainfall. Non-arable.

Impact Assessment Methodology

In order for the Environmental Assessment Practitioner (EAP) to allow for sufficient consideration of all environmental impacts, impacts were assessed using a common, defensible method of assessing significance that will enable comparisons to be made between risks/impacts and will enable authorities, stakeholders and the client to understand the process and rationale upon which risks/impacts have been assessed. The method to be used for assessing risks/impacts is outlined in the sections below.

The first stage of risk/impact assessment is the identification of environmental activities, aspects and impacts. This is supported by the identification of receptors and resources, which allows for an understanding of the impact pathway and an assessment of the sensitivity to change. The definitions used in the impact assessment are presented below.

- An **activity** is a distinct process or task undertaken by an organisation for which a responsibility can be assigned. Activities also include facilities or infrastructure that is possessed by an organisation.
- An **environmental aspect** is an 'element of an organizations activities, products and services which can interact with the environment'[1]. The interaction of an aspect with the environment may result in an impact.
- **Environmental risks/impacts** are the consequences of these aspects on environmental resources or receptors of particular value or sensitivity, for example, disturbance due to noise and health effects due to poorer air quality. In the case where the impact is on human health or wellbeing, this should be stated. Similarly, where the receptor is not anthropogenic, then it should, where possible, be stipulated what the receptor is.
- **Receptors** can comprise, but are not limited to, people or human-made systems, such as local residents, communities and social infrastructure, as well as components of the biophysical environment such as wetlands, flora and riverine systems.
- **Resources** include components of the biophysical environment.
- **Frequency of activity** refers to how often the proposed activity will take place.
- **Frequency of impact** refers to the frequency with which a stressor (aspect) will impact on the receptor.
- **Severity** refers to the degree of change to the receptor status in terms of the reversibility of the impact; sensitivity of receptor to stressor; duration of impact (increasing or decreasing with time); controversy potential and precedent setting; threat to environmental and health standards.
- **Spatial extent** refers to the geographical scale of the impact.
- **Duration** refers to the length of time over which the stressor will cause a change in the resource or receptor.

The significance of the impact is then assessed by rating each variable according to the defined criteria. Refer to the Table A1. The purpose of the rating is to develop a clear understanding of influences and

[1] The definition has been aligned with that used in the ISO 14001 Standard.

processes associated with each impact. The severity, spatial scope and duration of the impact together comprise the consequence of the impact and when summed can obtain a maximum value of 15. The frequency of the activity and the frequency of the impact together comprise the likelihood of the impact occurring and can obtain a maximum value of 10. The values for likelihood and consequence of the impact are then read off a significance-rating matrix and are used to determine whether mitigation is necessary[2].

The assessment of significance is undertaken twice. Initial, significance is based on only natural and existing mitigation measures (including built-in engineering designs). The subsequent assessment considers the recommended management measures required to mitigate the impacts. Measures such as demolishing infrastructure, and reinstatement and rehabilitation of land, are considered post-mitigation.

The model outcome of the impacts was then assessed in terms of impact certainty and consideration of available information. The Precautionary Principle is applied in line with South Africa's National Environmental Management Act 1998 (Act No. 108 of 1998) in instances of uncertainty or lack of information, by increasing assigned ratings or adjusting final model outcomes. In certain instances where a variable or outcome requires rational adjustment due to model limitations, the model outcomes have been adjusted.

Table A1: Criteria and definitions for assessing significance of impacts

LIKELIHOOD DESCRIPTORS

PART A: DEFINITIONS AND CRITERIA*		
Definition of SIGNIFICANCE		**Significance = consequence x probability**
Definition of CONSEQUENCE		**Consequence is a function of intensity, spatial extent and duration**
Criteria for ranking of the INTENSITY of environmental impacts	**VH**	Severe change, disturbance or degradation. Associated with severe consequences. May result in severe illness, injury or death. Targets, limits and thresholds of concern continually exceeded. Substantial intervention will be required. Vigorous/widespread community mobilization against project can be expected. May result in legal action if impact occurs.
	H	Prominent change, disturbance or degradation. Associated with real and substantial consequences. May result in illness or injury. Targets, limits and thresholds of concern regularly exceeded. Will definitely require intervention. Threats of community action. Regular complaints can be expected when the impact takes place.
	M	Moderate change, disturbance or discomfort. Associated with real but not substantial consequences. Targets, limits and thresholds of concern may occasionally be exceeded. Likely to require some intervention. Occasional complaints can be expected.
	L	Minor (Slight) change, disturbance or nuisance. Associated with minor consequences or deterioration. Targets, limits and thresholds of concern rarely exceeded. Require only minor interventions or clean-up actions. Sporadic complaints could be expected.
	VL	Negligible change, disturbance or nuisance. Associated with very minor consequences or deterioration. Targets, limits and thresholds of concern never exceeded. No interventions or clean-up actions required. No complaints anticipated.
	VL+	Negligible change or improvement. Almost no benefits. Change not measurable/will remain in the current range.
	L+	Minor change or improvement. Minor benefits. Change not measurable/will remain in the current range. Few people will experience benefits.
	M+	Moderate change or improvement. Real but not substantial benefits. Will be within or marginally better than the current conditions. Small number of people will experience benefits.
	H+	Prominent change or improvement. Real and substantial benefits. Will be better than current conditions. Many people will experience benefits. General community support.

[2] Some risks/impacts that have low significance will however still require mitigation.

	VH+	Substantial, large-scale change or improvement. Considerable and widespread benefit. Will be much better than the current conditions. Favourable publicity and/or widespread support expected.
Criteria for ranking the DURATION of impacts	VL	Very short, always less than a year. Quickly reversible
	L	Short-term, occurs for more than 1 but less than 5 years. Reversible over time.
	M	Medium-term, 5 to 10 years.
	H	Long term, between 10 and 20 years. (Likely to cease at the end of the operational life of the activity)
	VH	Very long, permanent, +20 years (Irreversible. Beyond closure)
Criteria for ranking the EXTENT of impacts	VL	A part of the site/property.
	L	Whole site.
	M	Beyond the site boundary, affecting immediate neighbours
	H	Local area, extending far beyond site boundary.
	VH	Regional/National

CONSEQUENCE DESCRIPTORS

Table A2: Determining Consequence and Significance

PART B: DETERMINING CONSEQUENCE							
INTENSITY = VL							
DURATION	Very long	VH	Low	Low	Medium	Medium	High
	Long term	H	Low	Low	Low	Medium	Medium
	Medium term	M	Very Low	Low	Low	Low	Medium
	Short term	L	Very low	Very Low	Low	Low	Low
	Very short	VL	Very low	Very Low	Very Low	Low	Low
INTENSITY = L							
DURATION	Very long	VH	Medium	Medium	Medium	High	High
	Long term	H	Low	Medium	Medium	Medium	High
	Medium term	M	Low	Low	Medium	Medium	Medium
	Short term	L	Low	Low	Low	Medium	Medium
	Very short	VL	Very low	Low	Low	Low	Medium
INTENSITY = M							
DURATION	Very long	VH	Medium	High	High	High	Very High
	Long term	H	Medium	Medium	Medium	High	High
	Medium term	M	Medium	Medium	Medium	High	High
	Short term	L	Low	Medium	Medium	Medium	High
	Very short	VL	Low	Low	Low	Medium	Medium
INTENSITY = H							
DURATION	Very long	VH	High	High	High	Very High	Very High
	Long term	H	Medium	High	High	High	Very High
	Medium term	M	Medium	Medium	High	High	High
	Short term	L	Medium	Medium	Medium	High	High
	Very short	VL	Low	Medium	Medium	Medium	High
INTENSITY = VH							
DURATION	Very long	VH	High	High	Very High	Very High	Very High
	Long term	H	High	High	High	Very High	Very High
	Medium term	M	Medium	High	High	High	Very High
	Short term	L	Medium	Medium	High	High	High
	Very short	VL	Low	Medium	Medium	High	High

			VL	L	M	H	VH
			A part of the site/ property	Whole site	Beyond the site, affecting neighbours	Extending far beyond site but localised	Regional/ National
			EXTENT				
PART C: DETERMINING SIGNIFICANCE							
PROBABILITY (of exposure to impacts)	Definite/ Continuous	VH	Very Low	Low	Medium	High	Very High
	Probable	H	Very Low	Low	Medium	High	Very High
	Possible/ frequent	M	Very Low	Very Low	Low	Medium	High
	Conceivable	L	Insignificant	Very Low	Low	Medium	High
	Unlikely/ improbable	VL	Insignificant	Insignificant	Very Low	Low	Medium
			VL	L	M	H	VVH
			CONSEQUENCE				

Table A3: Significance Rating and Interpretation

PART D: INTERPRETATION OF SIGNIFICANCE	
Significance	**Decision guideline**
Very High	Potential fatal flaw unless mitigated to lower significance.
High	It must have an influence on the decision. Substantial mitigation will be required.
Medium	It should have an influence on the decision. Mitigation will be required.
Low	Unlikely that it will have a real influence on the decision. Limited mitigation is likely required.
Very Low	It will not have an influence on the decision. Does not require any mitigation
Insignificant	Inconsequential, not requiring any consideration.

The following points were considered when undertaking the assessment:

- Risks and impacts were analysed in the context of the *project's area of influence* encompassing:
  - Primary project site and related facilities that the client and its contractors develop or controls;
  - Areas potentially impacted by cumulative impacts for any existing project or condition and other project-related developments; and
  - Areas potentially affected by impacts from unplanned but predictable developments caused by the project that may occur later or at a different location.
- Risks/Impacts were assessed for all stages of the project cycle including:
  - Pre-construction;
  - Construction; and
  - Operation.
- If applicable, transboundary or global effects were assessed.
- Individuals or groups who may be differentially or disproportionately affected by the project because of their *disadvantaged* or *vulnerable* status were assessed.
- Particular attention was paid to describing any residual impacts that will occur after rehabilitation.

Mitigation measure development

The following points present the key concepts considered in the development of mitigation measures for the proposed development.

- *Mitigation* and *performance improvement measures* and actions that address the risks and impacts[3] are identified and described in as much detail as possible.
- Measures and actions to address negative impacts will favour avoidance and prevention over minimisation, mitigation or compensation.

Recommendations

Recommendations were developed to address and mitigate impacts associated with the proposed development. These recommendations also include general management measures which apply to the proposed development as a whole. Mitigation measures have been developed to address issues in all phases throughout the life of the operation from planning, through to construction and operation.

[3] *Mitigation measures should address both positive and negative impacts*

APPENDIX B: DETAILS, EXPERTISE AND CURRICULUM VITAE OF SPECIALISTS

1. (a) (i) Details of the specialist who prepared the report

Stephen van Staden MSc (Environmental Management) (University of Johannesburg)

Braveman Mzila BSc (Hons) Environmental Hydrology University of KwaZulu-Natal

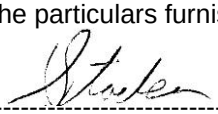
1. (a). (ii) The expertise of that specialist to compile a specialist report including a curriculum vitae

Company of Specialist:	Zimpande Research Collaborative		
Name / Contact person:	Stephen van Staden		
Postal address:	29 Arterial Road West, Oriel, Bedfordview		
Postal code:	2007	Cell:	083 415 2356
Telephone:	011 616 7893	Fax:	011 615 6240/ 086 724 3132
E-mail:	stephen@sasenvgroup.co.za		
Qualifications	MSc (Environmental Management) (University of Johannesburg) BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg) BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)		
Registration / Associations	Registered Professional Scientist at South African Council for Natural Scientific Professions (SACNASP) Accredited River Health practitioner by the South African River Health Program (RHP) Member of the South African Soil Surveyors Association (SASSO) Member of the Gauteng Wetland Forum		

1. (b) a declaration that the specialist is independent in a form as may be specified by the competent authority

I, Stephen van Staden, 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 relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, 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



Signature of the Specialist

1.(b) A declaration that the specialist is independent in a form as may be specified by the competent authority

I, Braveman Mzila, declare that -

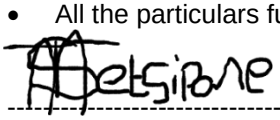
- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, 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

Signature of the Specialist

1. (b) a declaration that the specialist is independent in a form as may be specified by the competent authority

I, Tshiamo Setsipane, 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 relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, 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



Signature of the Specialist

SAS ENVIRONMENTAL GROUP OF COMPANIES –

SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF STEPHEN VAN STADEN

PERSONAL DETAILS

Position in Company	Group CEO, Water Resource discipline lead, Managing member, Ecologist, Aquatic Ecologist
Joined SAS Environmental Group of Companies	2003 (year of establishment)

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Registered Professional Scientist at South African Council for Natural Scientific Professions (SACNASP)
Accredited River Health practitioner by the South African River Health Program (RHP)
Member of the South African Soil Surveyors Association (SASSO) Member of the Gauteng Wetland Forum
Member of the Gauteng Wetland Forum;
Member of International Association of Impact Assessors (IAIA) South Africa;
Member of the Land Rehabilitation Society of South Africa (LaRSSA)

EDUCATION

Qualifications

MSc Environmental Management (University of Johannesburg)	2003
BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg)	2001
BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)	2000
Tools for wetland assessment short course Rhodes University	2016
Legal liability training course (Legricon Pty Ltd)	2018
Hazard identification and risk assessment training course (Legricon Pty Ltd)	2013

Short Courses

Certificate – Department of Environmental Science in Legal context of Environmental Management, Compliance and Enforcement (UNISA)	2009
Introduction to Project Management - Online course by the University of Adelaide	2016
Integrated Water Resource Management, the National Water Act, and Water Use Authorisations, focusing on WULAs and IWWMPs	2017

AREAS OF WORK EXPERIENCE

South Africa – All Provinces
Southern Africa – Lesotho, Botswana, Mozambique, Zimbabwe Zambia
Eastern Africa – Tanzania Mauritius
West Africa – Ghana, Liberia, Angola, Guinea Bissau, Nigeria, Sierra Leona
Central Africa – Democratic Republic of the Congo

KEY SPECIALIST DISCIPLINES

Biodiversity Assessments

- Floral Assessments
- Biodiversity Actions Plan (BAP)
- Biodiversity Management Plan (BMP)
- Alien and Invasive Control Plan (AICP)
- Ecological Scan
- Terrestrial Monitoring
- Protected Tree and Floral Marking and Reporting
- Biodiversity Offset Plan

Freshwater Assessments

- Desktop Freshwater Delineation
- Freshwater Verification Assessment
- Freshwater (wetland / riparian) Delineation and Assessment
- Freshwater Eco Service and Status Determination
- Rehabilitation Assessment / Planning
- Maintenance and Management Plans
- Plant species and Landscape Plan
- Freshwater Offset Plan
- Hydropedological Assessment
- Pit Closure Analysis

Aquatic Ecological Assessment and Water Quality Studies

- Habitat Assessment Indices (IHAS, HRC, IHIA & RHAM)
- Aquatic Macro-Invertebrates (SASS5 & MIRAI)
- Fish Assemblage Integrity Index (FRAI)
- Fish Health Assessments
- Riparian Vegetation Integrity (VEGRAI)
- Toxicological Analysis
- Water quality Monitoring
- Screening Test
- Riverine Rehabilitation Plans

Soil and Land Capability Assessment

- Soil and Land Capability Assessment
- Soil Monitoring
- Soil Mapping

Visual Impact Assessment

- Visual Baseline and Impact Assessments
- Visual Impact Peer Review Assessments
- View Shed Analyses
- Visual Modelling

Legislative Requirements, Processes and Assessments

- Water Use Applications (Water Use Licence Applications / General Authorisations)
- Environmental and Water Use Audits
- Freshwater Resource Management and Monitoring as part of EMPR and WUL conditions

SAS ENVIRONMENTAL GROUP OF COMPANIES –

SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF BRAVEMAN MZILA

PERSONAL DETAILS

Position in Company	Wetland Ecologist and Soil Scientist
Joined SAS Environmental Group of Companies	2017

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Member of the South African Soil Science Society (SASSO)

Member of the Gauteng Wetland Forum (GWF)

EDUCATION

Qualifications

BSc (Hons) Environmental Hydrology (University of Kwazulu-Natal)	2013
BSc Hydrology and Soil Science (University of Kwazulu-Natal)	2012

COUNTRIES OF WORK EXPERIENCE

South Africa – Gauteng, Mpumalanga, Free State, North West, Limpopo, Northern Cape, Eastern Cape, KwaZulu-Natal

KEY SPECIALIST DISCIPLINES

Hydropedological Assessments:

- Soil Survey
- Soil Delineation
- Hydrological hillslope classification
- Hydropedological loss Quantification
- Hydropedological impact assessment
- Scientific buffer determination

Soil, Land use, Land Capability and Agricultural Potential Studies

- Soil Desktop assessment
- Soil classification
- Agricultural potential
- Agricultural Impact Assessments

SAS ENVIRONMENTAL GROUP OF COMPANIES (SEGC) –
SPECIALIST CONSULTANT INFORMATION
CURRICULUM VITAE OF TSHIAMO SETSIPANE

PERSONAL DETAILS

Position in Company	Soil Scientist/ Hydropedologist
Joined SAS Environmental Group of Companies	2020

MEMBERSHIP IN PROFESSIONAL SOCIETIES

South African Council for Natural Scientist Professions (SACNASP)

EDUCATION

Qualifications

M.Sc. (Agric) Soil Science (*Cum Laude*)	(University of the Free State)	2019
B.Sc. (Agric) Honours Soil Science	(University of the Free State)	2014
B.Sc. (Agric) Soil Science & Agrometeorology	(University of the Free State)	2013

COUNTRIES OF WORK EXPERIENCE

South Africa – Kwa-Zulu Natal, Northern Cape, Mpumalanga and Free State

KEY SPECIALIST DISCIPLINES

Hydropedological Assessments:

- Soil Survey
- Soil Delineation
- Hydrological hillslope classification
- Hydropedological loss Quantification
- Hydropedological impact assessment
- Scientific buffer determination

Soil, Land use, Land Capability and Agricultural Potential Studies

- Soil Desktop assessment
- Soil classification
- Agricultural potential
- Agricultural Impact Assessments

APPENDIX H: SPECIALIST STUDIES
NOISE ASSESSMENT

Noise Specialist Study for Two New Vent Shafts at the Marula Platinum Mine in Limpopo

Project done for **SLR Consulting (South Africa) (Pty) Ltd**

Report compiled by:
Reneé von Gruenewaldt

Report No: 20SLR19N | **Date:** January 2022

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Report Details

Report Title	Noise Specialist Study for Two New Vent Shafts at the Marula Platinum Mine in Limpopo
Client	SLR Consulting (South Africa) (Pty) Ltd
Report Number	20SLR19N
Report Version	Rev 0.3
Date	January 2022
Prepared by	Renee von Gruenewaldt, (Pr. Sci. Nat.), MSc (University of Pretoria)
Reviewed by	Nick Grobler, BEng (Chem), BEng (Hons) (Env) (University of Pretoria)
Notice	Airshed Planning Professionals (Pty) Ltd is a consulting company located in Midrand, South Africa, specialising in all aspects of air quality and noise impacts, ranging from nearby neighbourhood concerns to regional impact assessments. The company originated in 1990 as Environmental Management Services, which amalgamated with its sister company, Matrix Environmental Consultants, in 2003.
Declaration	Airshed is an independent consulting firm with no interest in the project other than to fulfil the contract between the client and the consultant for delivery of specialised services as stipulated in the terms of reference.
Copyright Warning	

Revision Record

Version	Date	Comments
Rev 0	September 2020	For client review
Rev 0.1	November 2020	Incorporation of client's comments
Rev 0.2	November 2020	Incorporation of client's comments
Rev 0.3	January 2022	Assessment of noise berms

Glossary and Abbreviations

Airshed	Airshed Planning Professionals (Pty) Ltd
BAC	Bulk Air Cooler
CCT	Condenser Cooling Tower
dB	Descriptor that is used to indicate 10 times a logarithmic ratio of quantities that have the same units, in this case sound pressure.
dBA	Descriptor that is used to indicate 10 times a logarithmic ratio of quantities that have the same units, in this case sound pressure that has been A-weighted to simulate human hearing.
DC	Derek Cosijn
EIA	Environmental Impact Assessment
Hz	Frequency in Hertz
IEC	International Electrotechnical Commission
IFC	International Finance Corporation
ISO	International Standards Organisation
Kn	Noise propagation correction factor
K1	Noise propagation correction for geometrical divergence
K2	Noise propagation correction for atmospheric absorption
K3	Noise propagation correction for the effect of ground surface;
K4	Noise propagation correction for reflection from surfaces
K5	Noise propagation correction for screening by obstacles
kW	Power in kilowatt
L_{Aeq} (T)	The A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured) (in dBA)
L_{Aleq} (T)	The impulse corrected A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured) (in dBA)
$L_{Req,d}$	The L_{Aeq} rated for impulsive sound and tonality in accordance with SANS 10103 for the day-time period, i.e. from 06:00 to 22:00.
$L_{Req,n}$	The L_{Aeq} rated for impulsive sound and tonality in accordance with SANS 10103 for the night-time period, i.e. from 22:00 to 06:00.
$L_{R,dn}$	The L_{Aeq} rated for impulsive sound and tonality in accordance with SANS 10103 for the period of a day and night, i.e. 24 hours, and wherein the $L_{Req,n}$ has been weighted with 10dB in order to account for the additional disturbance caused by noise during the night.
L_{A90}	The A-weighted 90% statistical noise level, i.e. the noise level that is exceeded during 90% of the measurement period. It is a very useful descriptor which provides an indication of what the L_{Aeq} could have been in the absence of noisy single events and is considered representative of background noise levels (L_{A90}) (in dBA)
L_{AFmax}	The A-weighted maximum sound pressure level recorded during the measurement period
L_{AFmin}	The A-weighted minimum sound pressure level recorded during the measurement period
L_P	Sound pressure level (in dB)
Ltd	Limited
L_W	Sound Power Level (in dB)

masl	Meters above sea level
m^2	Area in square meters
MM5	Fifth-Generation Penn State/NCAR Mesoscale Model
m/s	Speed in meters per second
MW	Power in megawatt
NACA	National Association for Clean Air
NEMA	National Environmental Management Act
NEMAQA	National Environmental Management Air Quality Act
NLG	Noise level guideline
NSR	Noise sensitive receptor
p	Pressure in Pa
Pa	Pressure in Pascal
µPa	Pressure in micro-pascal
p_{ref}	Reference pressure, 20 µPa
Pty	Proprietary
SABS	South African Bureau of Standards
SACNASP	South African Council for Natural Scientific Professions
SANS	South African National Standards
SLM	Sound Level Meter
SoW	Scope of Work
STRM	Shuttle Radar Topography Mission
USGS	United States Geological Survey
WHO	World Health Organisation
%	Percentage

Executive Summary

The Marula Platinum Mine in Limpopo is proposing to develop two new vent shafts, both of which will have aboveground fans. There will also be three shafts which will have additional infrastructure of bulk air coolers and refrigeration plants. The proposed operations are hereafter referred to as the project.

Airshed Planning Professionals (Pty) Ltd (Airshed) was commissioned by SLR Consulting (South Africa) (Pty) Ltd to undertake a specialist environmental noise impact study for the project as input to the Environmental Impact Assessment.

The main objective of the noise specialist study was to determine the potential impact on the acoustic environment and noise sensitive receptors (NSRs) as a result of the development of the proposed project and to recommend suitable management and mitigation measures. To meet the above objective, the following tasks were included in the Scope of Work (SoW):

1. A review of available technical project information.
2. A review of the legal requirements and applicable environmental noise guidelines.
3. A study of the receiving (baseline) acoustic environment, including:
    a. The identification of NSRs from available maps and field observations;
    b. A study of environmental noise attenuation potential by referring to available weather records, land use and topography data sources; and
    c. Determining representative baseline noise levels through the analysis of sampled environmental noise levels obtained from surveys conducted on 17 and 18 August 2020.
4. An impact assessment, including:
    a. The establishment of a source inventory for proposed activities.
    b. Noise propagation simulations to determine environmental noise levels as a result of the project.
    c. The screening of simulated noise levels against environmental noise criteria.
5. The identification and recommendation of suitable mitigation measures and monitoring requirements.
6. The preparation of a comprehensive specialist noise impact assessment report.

In the assessment of simulated noise levels, reference was made to the IFC noise level guidelines for residential, institutional and educational receptors (55 dBA during the day (06:00-22:00) and 45 dBA during the night (22:00-06:00)) which is in line with the SANS 10103 rating for urban districts.

The baseline acoustic environment was described in terms of the location of NSRs, the ability of the environment to attenuate noise over long distances, as well as existing background and baseline noise levels. The following was found:

- The closest NSRs include residential developments of Winnaarshoek (~80 m from project activities), Diphale (~600 m from project activities) and Galane (~300 m from project activities).
- The average baseline noise levels (as measured during the field survey) were 43 dBA during the day and 33.8 dBA during the night.

Noise emissions from mobile and non-mobile equipment were estimated using L_W predictions for industrial machinery (Bruce & Moritz, 1998), where L_W estimates are a function of the power rating of the equipment engine.

The source inventory, local meteorological conditions and information on local land use were used to populate the noise propagation model (CadnaA, ISO 9613). The propagation of noise was calculated over an area of 6.25 km east-west by 6.5 km north-south. The area was divided into a grid matrix with a 25-m resolution.

The main findings of the impact assessment are:

- A general management and mitigation plan, as stipulated in Section 5, is recommended to minimise noise impacts from the project on the surrounding area.
- The simulated equivalent continuous day-time rating level ($L_{Req,d}$) due to project operations of 55 dBA (IFC guideline level) extends ~450 m from the project operations.
- The simulated equivalent continuous night-time rating level ($L_{Req,n}$) of 45 dBA (IFC guideline level) due to project operations extends ~450 m to ~730 m from the project operations.
- Construction and closure phase impacts are expected to be similar or slightly lower than simulated noise impacts of the operational phase.
- The significance of the project operations is high for unmitigated and medium for mitigated activities due to the close proximity of sensitive receptors.

Based on the findings of the assessment and provided the recommended management and mitigation measures are in place, it is the specialist's opinion that the project may be authorised.

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1 Introduction

The Marula Platinum Mine in Limpopo is proposing to develop two new vent shafts, both of which will have aboveground fans. There will also be three ventilation shafts which will have additional infrastructure of bulk air coolers and refrigeration plants. A summary of the proposed infrastructure (hereafter referred to as the project) is provided in Table 1.

Table 1: Summary of the proposed infrastructure

Shaft	EMPr Status	Additional requirements that need approval
DRIEKOP SHAFT COMPLEX		
V#6	Existing and approved shaft	Requires a new bulk air cooler, refrigeration plant and condenser cooling towers.
V#9	New shaft	New vent shaft with surface main fans and electrical rooms.
CLAPHAM SHAFT COMPLEX		
V#5	Existing and approved shaft	Requires a new Bulk Air Cooler.
V#7	Approved shaft but not yet established	Authorisation is needed for surface main fans, electrical rooms, refrigeration plant and condenser cooling towers.
V#8	New shaft	Authorisation is needed for the new vent shaft with bulk air cooler.

Airshed Planning Professionals (Pty) Ltd (Airshed) was commissioned by SLR Consulting (South Africa) (Pty) Ltd to undertake a specialist environmental noise impact study for the project as an input to the Environmental Impact Assessment (EIA).

The location of the project is provided in Figure 1. The proposed layout for the Driekop and Clapham complexes are provided in Figure 2 and Figure 3 respectively.

1.1 Study Objective

The main objective of the noise specialist study was to determine the potential impact on the acoustic environment and noise sensitive receptors (NSRs) as a result of the operations at the project site and to recommend suitable management and mitigation measures.

Figure 1: Location of the proposed project

Figure 2: Layout of the Driekop complex (provided by BEE Consulting)

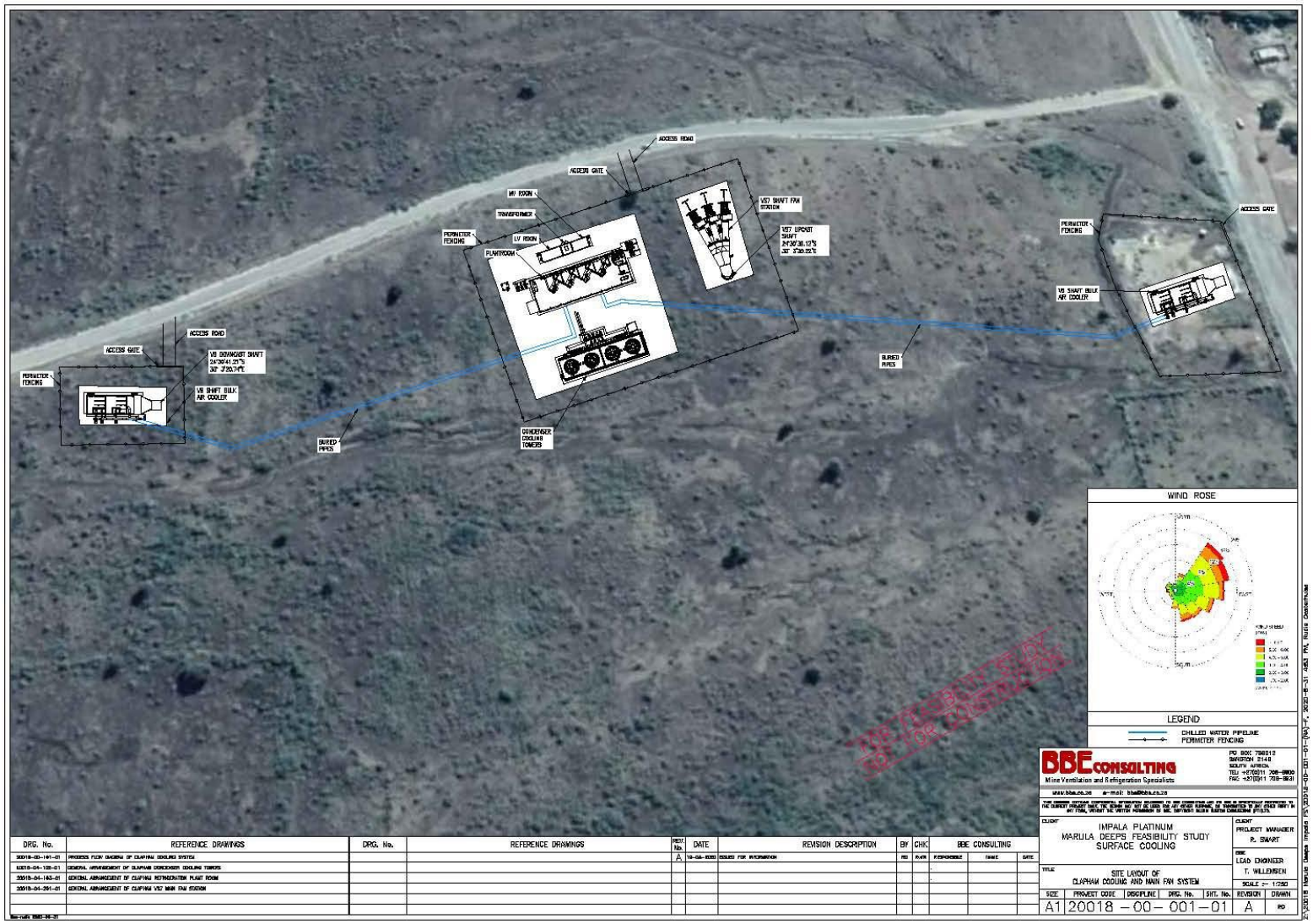


Figure 3: Layout of the Clapham complex (provided by BEE Consulting)

1.2 Scope of Work

To meet the above objective, the following tasks were included in the Scope of Work (SoW):

1. A review of available technical project information.
2. A review of the legal requirements and applicable environmental noise guidelines.
3. A study of the receiving (baseline) acoustic environment, including:
    a. The identification of NSRs from available maps and field observations.
    b. A study of environmental noise attenuation potential by referring to available weather records, land use and topography data sources.
    c. Determining representative baseline noise levels through the analysis of sampled environmental noise levels obtained from survey conducted on 17 and 18 August 2020.
4. An impact assessment, including:
    a. The establishment of a source inventory for proposed activities.
    b. Noise propagation simulations to determine environmental noise levels as a result of the project activities.
    c. The screening of simulated noise levels against environmental noise criteria.
5. The identification and recommendation of suitable mitigation measures and monitoring requirements.
6. The preparation of a comprehensive specialist noise impact assessment report.

1.3 Specialist Details

1.3.1 Specialist Details

Airshed is an independent consulting firm with no interest in the project other than to fulfil the contract between the client and the consultant for delivery of specialised services as stipulated in the terms of reference. A Declaration of Independence is provided in Appendix B.

1.3.2 Competency Profile of Specialist

Reneé von Gruenewaldt is a Registered Professional Natural Scientist (Registration Number 400304/07) with the South African Council for Natural Scientific Professions (SACNASP) and a member of the National Association for Clean Air (NACA).

Following the completion of her bachelor's degree in atmospheric sciences in 2000 and honours degree (with distinction) with specialisation in Environmental Analysis and Management in 2001 at the University of Pretoria, her experience in air pollution started when she joined Environmental Management Services (now Airshed Planning Professionals) in 2002. Reneé von Gruenewaldt later completed her master's degree (with distinction) in Meteorology at the University of Pretoria in 2009.

Reneé von Gruenewaldt became a partner of Airshed Planning Professionals in September 2006. Airshed Planning Professionals is a technical and scientific consultancy providing scientific, engineering, and strategic air pollution

impact assessment and management services and policy support to assist clients in addressing a wide variety of air pollution and environmental noise related assessments.

She has experience on the various components of environmental noise assessments from 2015 to present. Her project experience range over various countries in Africa, providing her with an inclusive knowledge base of international legislation and requirements pertaining to noise impacts.

A comprehensive curriculum vitae of Reneé von Gruenewaldt is provided in Appendix A.

1.4 Description of Activities from a Noise Perspective

Sources of noise at the proposed project operational phase are expected to include:

- Vents.
- Compressors.
- Cranes and crawls.
- Rotating machinery such as motors, pumps, fans, etc. For a given machine, the sound pressure level ('emission') depends on the proportion of the total mechanical or electrical energy that is transformed into acoustical energy.

It is understood that the refrigeration plant will be in a building with concrete floor and metal sheeting. The motor to drive the surface fans will also be enclosed. This will provide acoustic shielding to the outside through absorption of acoustic energy and transmission losses.

Construction and decommissioning will also contribute to noise levels. The significance of impacts due to these phases have been provided in Section 5.

1.5 Background to Environmental Noise and the Assessment Thereof

Before more details regarding the approach and methodology adopted in the assessment is given, the reader is provided with some background, definitions and conventions used in the measurement, calculation and assessment of environmental noise.

Noise is generally defined as unwanted sound transmitted through a compressible medium such as air. Sound in turn, is defined as any pressure variation that the ear can detect. Human response to noise is complex and highly variable as it is subjective rather than objective.

A direct application of linear scales (in pascal (Pa)) to the measurement and calculation of sound pressure leads to large and unwieldy numbers. As the ear responds logarithmically rather than linearly to stimuli, it is more practical to express acoustic parameters as a logarithmic ratio of the measured value to a reference value. This logarithmic ratio is called a decibel or dB. The advantage of using dB can be clearly seen in Figure 4. Here, the linear scale with its large numbers is converted into a manageable scale from 0 dB at the threshold of hearing (20 micro-

pascals (µPa)) to 130 dB at the threshold of pain (~100 Pa) (Brüel & Kjær Sound & Vibration Measurement A/S, 2000).

As explained, noise is reported in dB. "dB" is the descriptor that is used to indicate 10 times a logarithmic ratio of quantities that have the same units, in this case sound pressure. The relationship between sound pressure and sound pressure level is illustrated in this equation.

$$L_p = 20 \cdot \log_{10}\left(\frac{p}{p_{ref}}\right)$$

Where:

L_p *is the sound pressure level in dB;*

p *is the actual sound pressure in Pa; and*

p_{ref} *is the reference sound pressure (p_{ref} in air is 20 µPa).*

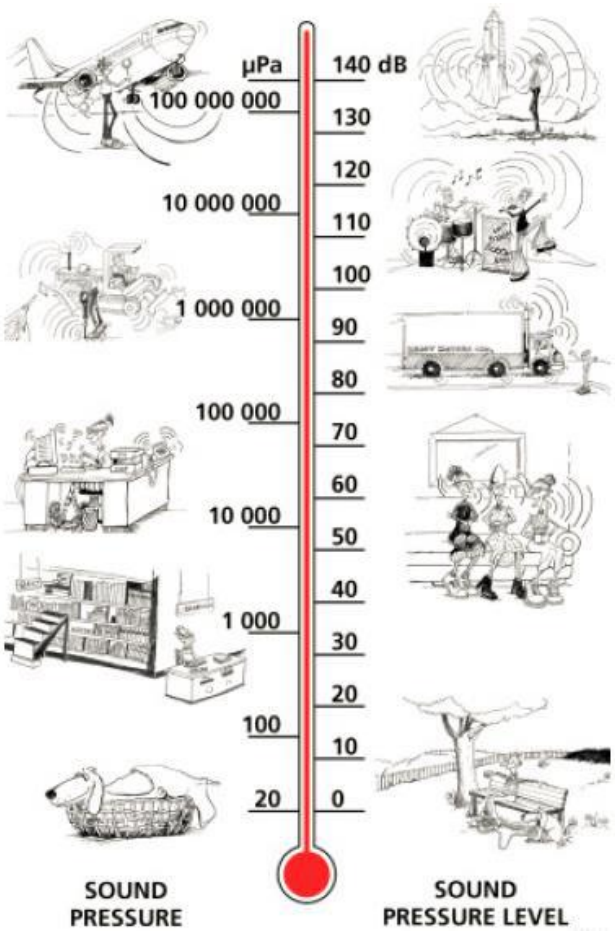


Figure 4: The decibel scale and typical noise levels (Brüel & Kjær Sound & Vibration Measurement A/S, 2000)

1.5.1 Perception of Sound

Sound has already been defined as any pressure variation that can be detected by the human ear. The number of pressure variations per second is referred to as the frequency of sound and is measured in hertz (Hz). The hearing frequency of a young, healthy person ranges between 20 Hz and 20 000 Hz.

In terms of L_P, audible sound ranges from the threshold of hearing at 0 dB to the pain threshold of 130 dB and above. Even though an increase in sound pressure level of 6 dB represents a doubling in sound pressure, an increase of 8 to 10 dB is required before the sound subjectively appears to be significantly louder. Similarly, the smallest perceptible change is about 1 dB (Brüel & Kjær Sound & Vibration Measurement A/S, 2000).

1.5.2 Frequency Weighting

Since human hearing is not equally sensitive to all frequencies, a 'filter' has been developed to simulate human hearing. The 'A-weighting' filter simulates the human hearing characteristic, which is less sensitive to sounds at low frequencies than at high frequencies (Figure 5). "dBA" is the descriptor that is used to indicate 10 times a logarithmic ratio of quantities that have the same units (in this case sound pressure) and have been A-weighted.

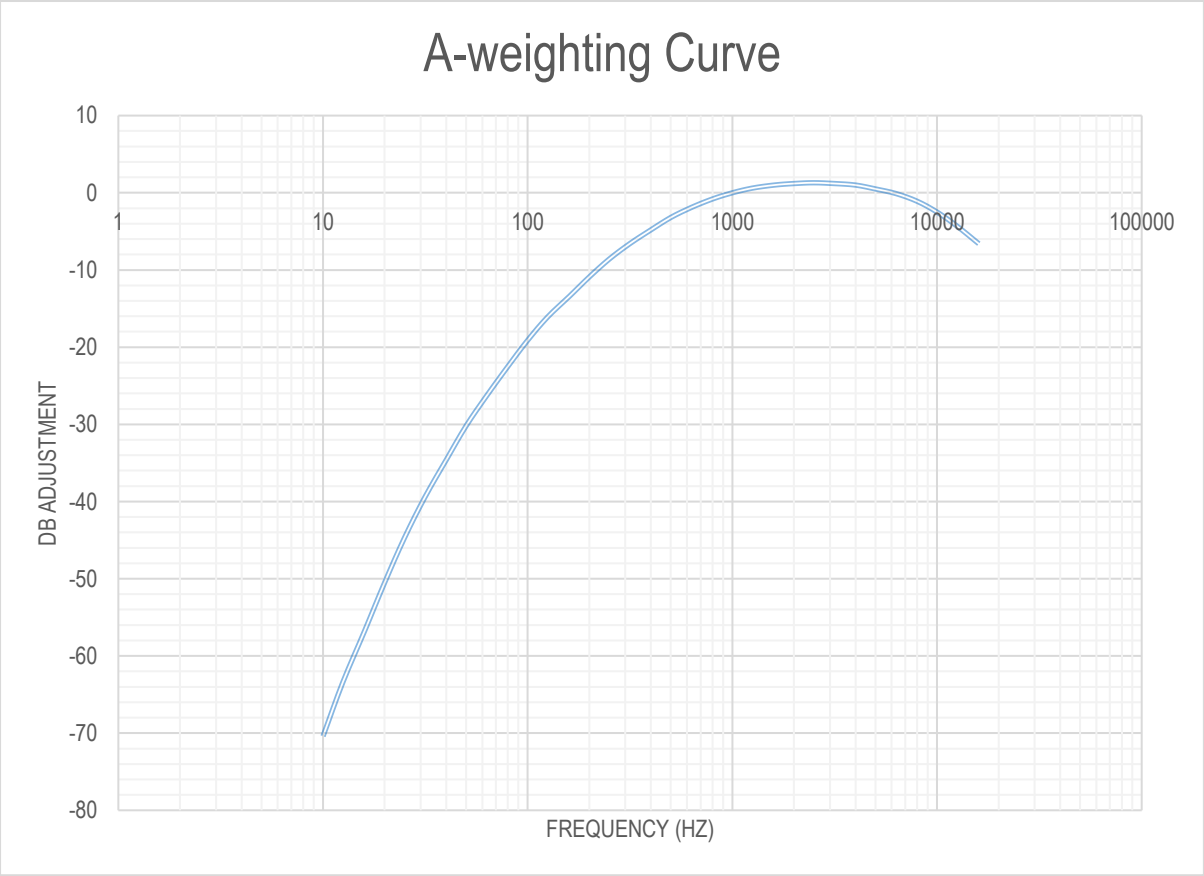


Figure 5: A-weighting curve

1.5.3 Adding Sound Pressure Levels

Since sound pressure levels are logarithmic values, the sound pressure levels as a result of two or more sources cannot simply be added together. To obtain the combined sound pressure level of a combination of sources such as those at an industrial plant, individual sound pressure levels must be converted to their linear values and added using:

$$L_{p\_combined} = 10 \cdot \log\left(10^{\frac{L_{p1}}{10}} + 10^{\frac{L_{p2}}{10}} + 10^{\frac{L_{p3}}{10}} + \cdots 10^{\frac{L_{pi}}{10}}\right)$$

This implies that if the difference between the sound pressure levels of two sources is nil the combined sound pressure level is 3 dB more than the sound pressure level of one source alone. Similarly, if the difference between the sound pressure levels of two sources is more than 10 dB, the contribution of the quietest source can be disregarded (Brüel & Kjær Sound & Vibration Measurement A/S, 2000).

1.5.4 Environmental Noise Propagation

Many factors affect the propagation of noise from source to receiver. The most important of these are:

- The type of source and its sound power (L_W);
- The distance between the source and the receiver;
- Atmospheric conditions (wind speed and direction, temperature and temperature gradient, humidity etc.);
- Obstacles such as barriers or buildings between the source and receiver;
- Ground absorption; and
- Reflections.

To arrive at a representative result from either measurement or calculation, all these factors must be taken into account (Brüel & Kjær Sound & Vibration Measurement A/S, 2000).

1.5.5 Environmental Noise Indices

In assessing environmental noise either by measurement or calculation, reference is made to the following indices:

- **L_{Zeq} (T)** – The unweighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured).
- **L_{Aeq} (T)** – The A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured).
- **L_{A90}** – The A-weighted 90% statistical noise level, i.e. the noise level that is exceeded during 90% of the measurement period. It is a very useful descriptor which provides an indication of what the L_{Aeq} could have been in the absence of noisy single events and is considered representative of background noise levels.
- **L_{AFmax}** – The maximum A-weighted noise level measured with the fast time weighting. It's the highest level of noise that occurred during a sampling period.

1.6 Approach and Methodology

The assessment included a study of the legal requirements pertaining to environmental noise impacts, a study of the physical environment of the area surrounding the project and the analyses of existing noise levels in the area. The impact assessment focused on the estimation of sound power levels (L_W's) (noise 'emissions') and sound pressure levels (L_P's) (noise impacts) associated with the operational phase. The findings of the assessment components informed recommendations of management measures, including mitigation and monitoring. Individual aspects of the noise impact assessment methodology are discussed in more detail below.

1.6.1 Information Review

An information requirements list was sent to SLR Consulting (South Africa) (Pty) Ltd at the onset of the project. In response to the request, the following information was supplied:

- Layout maps;
- Project equipment details.

1.6.2 Review of Assessment Criteria

In South Africa, provision is made for the regulation of noise under the National Environmental Management Air Quality Act (NEMAQA) (Act. 39 of 2004) but environmental noise limits have yet to be set. It is believed that when published, national criteria will make extensive reference to SANS 10103 of 2008 '*The measurement and rating of environmental noise with respect to annoyance and to speech communication'*. This standard has been widely applied in South Africa and is frequently used by local authorities when investigating noise complaints. These guidelines, which are in line with those published by the IFC in their *General EHS Guidelines* (IFC 2007) and World Health Organisation (WHO) *Guidelines for Community Noise* (WHO 1999), were considered in the assessment.

1.6.3 Study of the Receiving Environment

NSRs generally include private residences, community buildings such as schools, hospitals and any publicly accessible areas outside an industrial facility's property.

The ability of the environment to attenuate noise as it travels through the air was studied by considering local meteorology, land use and terrain.

Readily available terrain data was obtained from the United States Geological Survey (USGS) web site (https://earthexplorer.usgs.gov/) accessed on August 2020. A study was made of Shuttle Radar Topography Mission (STRM) 1 arc-sec data.

1.6.4 Noise Survey

The extent of noise impacts as a result of an intruding noise depends largely on existing noise levels in an area. Higher ambient noise levels will result in less noticeable noise impacts and a smaller impact area. The opposite also holds true. Increases in noise will be more noticeable in areas with low ambient noise levels. The data from a baseline noise survey conducted on 17 and 18 August 2020 was studied to determine current noise levels within the area.

The survey methodology, which closely followed guidance provided by the IFC (2007) and SANS 10103 (2008), is summarised below:

- The survey was designed and conducted by a trained specialist.
- Sampling was carried out using a Type 1 sound level meter (SLM) that meet all appropriate International Electrotechnical Commission (IEC) standards and is subject to calibration by an accredited laboratory (Appendix C). Equipment details are included in Table 2.
- The acoustic sensitivity of the SLM was tested with a portable acoustic calibrator before and after each sampling session.
- Samples, 10 to 30 minutes in duration, representative and sufficient for statistical analysis were taken with the use of the portable SLM capable of logging data continuously over the sampling time period. Samples representative of the day- and night-time acoustic environment were taken. SANS 10103 defines day-time as between 06:00 and 22:00 and night-time between 22:00 and 06:00 (SANS 10103, 2008).
- L_{Aleq} (T), L_{Aeq} (T); L_{AFmax}; L_{AFmin}; L_{90} and 3rd octave frequency spectra were recorded.
- The SLM was located approximately 1.5 m above the ground and no closer than 3 m to any reflecting surface.
- SANS 10103 states that one must ensure (as far as possible) that the measurements are not affected by the residual noise and extraneous influences, e.g. wind, electrical interference and any other non-acoustic interference, and that the instrument is operated under the conditions specified by the manufacturer.
- A detailed log and record were kept. Records included site details, weather conditions during sampling and observations made regarding the acoustic environment of each site (Appendix D).

Table 2: Sound level meter details

Equipment	Serial Number	Purpose	Last Calibration Date
Brüel & Kjær Type 2250 Lite SLM	S/N 2731851	Attended 60-minute sampling.	24 October 2019
Brüel & Kjær Type 4950 ½" Pre-polarized microphone	S/N 3177677	Attended 60-minute sampling.	24 October 2019
SVANTEK SV33 Class 1 Acoustic Calibrator	S/N 43170	Testing of the acoustic sensitivity before and after each daily sampling session.	25 October 2019
Kestrel 4000 Pocket Weather Tracker	S/N 559432	Determining wind speed, temperature and humidity during sampling.	Not Applicable

1.6.5 Source Inventory

To determine the change in noise impacts associated with the project, a source inventory was developed. A list of processing plant mechanical equipment was made available for study. L_W's for these were calculated using predictive equations for industrial machinery as per the Handbook of Acoustics, Chapter 69, by Bruce and Moritz (1998).

L_W's for the crane and crawl were obtained from the database of Derek Cosijn (DC) based on source measurements for similar operations. All source measurements were carried out in accordance with the procedures specified in SANS 10103.

Construction and decommissioning activities are expected to result in noise impacts similar to or less significant than impacts associated with the operational phase. Due to the nature of these phases, the noise levels would also vary from one day to the next. A source inventory was therefore only developed for the operational phase of the project.

1.6.6 Noise Propagation Simulations

The propagation of noise from proposed activities was simulated with the DataKustic CadnaA software. Use was made of the International Organisation for Standardization's (ISO) 9613 module for outdoor noise propagation from industrial noise sources.

ISO 9613 specifies an engineering method for calculating the attenuation of sound during propagation to predict the levels of environmental noise at a distance from a variety of sources. The method predicts the equivalent continuous A-weighted sound pressure level under meteorological conditions favourable to propagation from sources of known sound emission. These conditions are for downwind propagation or, equivalently, propagation under a well-developed moderate ground-based temperature inversion, as would commonly occurs at night.

The method also predicts an average A-weighted sound pressure level. The average A-weighted sound pressure level encompasses levels for a wide variety of meteorological conditions. The method specified in ISO 9613 consists specifically of octave-band algorithms (with nominal mid-band frequencies from 63 Hz to 8 kHz) for calculating the attenuation of sound which originates from a point sound source, or an assembly of point sources. The source (or sources) may be moving or stationary. Specific terms are provided in the algorithms for the following physical effects: geometrical divergence, atmospheric absorption, ground surface effects, reflection and obstacles. A basic representation of the model is given in the equation below:

$$L_P = L_W - \sum [K_1, K_2, K_3, K_4, K_5, K_6]$$

Where;

***L_P** is the sound pressure level at the receiver;*
***L_W** is the sound power level of the source;*
***K_1** is the correction for geometrical divergence;*

***K_2** is the correction for atmospheric absorption;*
***K_3** is the correction for the effect of ground surface;*
***K_4** is the correction for reflection from surfaces; and*
***K_5** is the correction for screening by obstacles.*

This method is applicable in practice to a great variety of noise sources and environments. It is applicable, directly or indirectly, to most situations concerning road or rail traffic, industrial noise sources, construction activities, and many other ground-based noise sources.

To apply the method of ISO 9613, several parameters need to be known with respect to the geometry of the source and of the environment, the ground surface characteristics, and the source strength in terms of octave-band sound power levels for directions relevant to the propagation.

1.6.6.1 Simulation Domain

If the dimensions of a noise source are small compared with the distance to the listener, it is called a point source. All sources were quantified as point sources or areas/lines represented by point sources. The sound energy from a point source spreads out spherically, so that the sound pressure level is the same for all points at the same distance from the source and decreases by 6 dB per doubling of distance. This holds true until ground and air attenuation noticeably affect the level. The impact of an intruding industrial noise on the environment will therefore rarely extend over more than 5 km from the source and is therefore always considered "local" in extent.

The propagation of noise was calculated over an area of 6.25 km east-west by 6.5 km north-south and encompasses the proposed project site. The area was divided into a grid matrix with a 25 m resolution. The model was set to calculate L_P's at each grid and discrete receptor point at a height of 1.5 m above ground level.

1.6.7 Presentation of Results

Results are presented in tabular and isopleth form. An isopleth is a line on a map connecting points at which a given variable (in this case sound pressure, L_P) has a specified constant value. This is analogous to contour lines on a map showing terrain elevation. In the assessment of environmental noise, isopleths present lines of constant noise level as a function of distance.

Simulated noise levels were assessed according to guidelines published in SANS 10103 and by the IFC. To assess annoyance at nearby places of residence, the increase in noise levels above the baseline at NSRs were calculated and compared to guidelines published in SANS 10103.

1.6.8 Recommendations of Management and Mitigation

The findings of the noise specialist study informed the recommendation of suitable noise management and mitigation measures.

1.6.9 Impact Significance Assessment

The significance of environmental noise impacts was assessed according to the methodology provided by SLR Consulting (South Africa) (Pty) Ltd and considered both an unmitigated and mitigated scenario. Refer to Appendix F of this report for the methodology.

1.7 Management of Uncertainties

The following limitations and assumptions should be noted:

- Meteorological data set was based on MM5 data for the period 2008-2010. This limitation is not found to be significant, however, as the meteorological conditions within the study area have not shown any significant historical changes.
- The quantification of sources of noise was limited to the operational phase of the project. Construction and closure phase activities are expected to be similar or less significant and its impacts only assessed qualitatively. Noise impacts will cease post-closure.
- The assessment is based on the list of equipment and information provided by BBE Consulting. The assumption is that this information is correct and reflects the routine operational phase of the project.
- Process activities were assumed to be 24 hours per day, 7 days per week.
- Although other existing sources of noise within the area were identified during the survey, such sources were not quantified but were taken into account during the baseline sampling.

2 Legal Requirements and Noise Level Guidelines

2.1 National Noise Control Regulations

The 1992 Noise Control Regulations (The Republic of South Africa, 1992) published in terms of Section 25 of the Environment Conservation Act (Act no. 73 of 1989) defines a "disturbing noise" as a noise level which exceeds the zone sound level or, if no zone sound level has been designated, a noise level which exceeds the ambient sound level at the same measuring point by 7 dBA or more.

2.2 South African National Standards

In South Africa, provision is made for the regulation of noise under the National Environmental Management Air Quality Act (NEMAQA) (Act. 39 of 2004) but legally enforceable environmental noise limits have yet to be set. It is believed that when published, national criteria will make extensive reference to the South African Bureau of Standards (SABS) standard SANS 10103 (2008) *'The measurement and rating of environmental noise with respect to annoyance and to speech communication'*. This standard has been widely applied in South Africa and is frequently used by local authorities when investigating noise complaints. The standard is also fully aligned with the WHO guidelines for Community Noise (WHO, 1999). It should be noted that the values given in Table 3 are typical rating levels that it is recommended should not be exceeded outdoors in the different districts specified. Outdoor ambient noise exceeding these levels will be annoying to the community.

Table 3: Typical rating levels for outdoor noise

Type of district	Equivalent Continuous Rating Level ($L_{Req,T}$) for Outdoor Noise		
	Day/night $L_{R,dn}$[(c)] (dBA)	Day-time $L_{Req,d}$[(a)] (dBA)	Night-time $L_{Req,n}$[(b)] (dBA)
Rural districts	45	45	35
Suburban districts with little road traffic	50	50	40
Urban districts	55	55	45
Urban districts with one or more of the following: business premises; and main roads.	60	60	50
Central business districts	65	65	55
Industrial districts	70	70	60

Notes

(a) $L_{Req,d}$ =The L_{Aeq} rated for impulsive sound and tonality in accordance with SANS 10103 for the day-time period, i.e. from 06:00 to 22:00.

(b) $L_{Req,n}$ =The L_{Aeq} rated for impulsive sound and tonality in accordance with SANS 10103 for the night-time period, i.e. from 22:00 to 06:00.

(c) $L_{R,dn}$ =The L_{Aeq} rated for impulsive sound and tonality in accordance with SANS 10103 for the period of a day and night, i.e. 24 hours, and wherein the $L_{Req,n}$ has been weighted with 10dB in order to account for the additional disturbance caused by noise during the night.

SANS 10103 also provides a useful guideline for estimating community response to an increase in the general ambient noise level caused by intruding noise. If Δ is the increase in noise level, the following criteria are of relevance:

- "$\Delta \leq 0$ dB: There will be no community reaction;
- 0 dB < $\Delta \leq 10$ dB: There will be 'little' reaction with 'sporadic complaints';
- 5 dB < $\Delta \leq 15$ dB: There will be a 'medium' reaction with 'widespread complaints'. $\Delta = 10$ dB is subjectively perceived as a doubling in the loudness of the noise;
- 10 dB < $\Delta \leq 20$ dB: There will be a 'strong' reaction with 'threats of community action'; and
- 15 dB < Δ: There will be a 'very strong' reaction with 'vigorous community action'.

The categories of community response overlap because the response of a community does not occur as a stepwise function, but rather as a gradual change.

2.3 International Finance Corporation Guidelines on Environmental Noise

The IFC General Environmental Health and Safety Guidelines on noise address impacts of noise beyond the property boundary of the facility under consideration and provides noise level guidelines.

The IFC states that noise impacts **should not exceed the levels presented in Table 4**, or result in a maximum **increase above background levels of 3 dBA** at the nearest receptor location off-site (IFC, 2007). For a person with average hearing acuity an increase of less than 3 dBA in the general ambient noise level is not detectable. $\Delta = 3$ dBA is, therefore, a useful significance indicator for a noise impact.

It is further important to note that the IFC noise level guidelines for residential, institutional and educational receptors correspond with the SANS 10103 guidelines for urban districts.

Table 4: IFC noise level guidelines

Area	One Hour L_{Aeq} (dBA) 07:00 to 22:00	One Hour L_{Aeq} (dBA) 22:00 to 07:00
Industrial receptors	70	70
Residential, institutional and educational receptors	55	45

2.4 Summary of Assessment Criteria

Simulated noise levels were assessed according to guidelines published by the IFC. To assess annoyance at nearby places of residence, the increase in noise levels above the baseline at NSRs were calculated and compared to guidelines published in SANS 10103.

2.5 Regulations Regarding Report Writing

This report complies with the requirements of the National Environmental Management Act, 1998 (NEMA, No 107 of 1998) and the Environmental Impact Assessment (EIA) regulations(EIA Regulations, 2014 (GN R 982, as amended in 2016, 2017, 2018 and 2020)).. The table below provides a summary of the requirements, with cross references to the report sections where these requirements have been addressed.

Table 5: Specialist report requirements in terms of Appendix 6 of the EIA Regulations (2014), as amended in 2017

A specialist report prepared in terms of the Environmental Impact Regulations of 2014 (as amended in 2017) must contain:	Relevant section in report
Details of the specialist who prepared the report	Section 1.3
The expertise of that person to compile a specialist report including a curriculum vitae	Section 1.3.2 Appendix A
A declaration that the person is independent in a form as may be specified by the competent authority	Section 1.3.1 Appendix B
An indication of the scope of, and the purpose for which, the report was prepared	Section 1.2
An indication of the quality and age of base data used for the specialist report;	Section 3.2 Section 3.3
A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 4
The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	Section 3.3 Section 4.2
A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Section 1.6
Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternative;	Section 3.1
An identification of any areas to be avoided, including buffers	Section 3.1 Section 4.2
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 4.2
A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 1.7
A description of the findings and potential implications of such findings on the impact of the proposed activity or activities	Section 4.2
Any mitigation measures for inclusion in the EMPr	Section 6
Any conditions for inclusion in the environmental authorisation	Section 6
Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 6
A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	Section 7
Regarding the acceptability of the proposed activity or activities; and	Section 4.2
If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	Section 4.2 Section 6 Section 7
A description of any consultation process that was undertaken during the course of carrying out the study	Not applicable

A specialist report prepared in terms of the Environmental Impact Regulations of 2014 (as amended in 2017) must contain:	Relevant section in report
A summary and copies if any comments that were received during any consultation process	None received
Any other information requested by the competent authority.	None received

2.6 Procedures for the Assessment

This report complies with protocols for the assessment and minimum report content in terms of sections 24(5)(a), (h) and 44 of the National Environmental Management Act, 1998 (NEMA, No 107 of 1998) (Government Gazette No. 43110) published on 20 March 2020. The table below provides a summary of the requirements, with cross references to the report sections where these requirements have been addressed.

Table 6: Specialist assessment requirements in terms of Government Gazette No. 43110 (2020)

Assessment and Reporting on Noise Impacts	Section in Report
The assessment must be undertaken by a noise specialist	Section 1.3 and Appendix A
The assessment must be undertaken based on a site inspection as well as applying the noise standards and methodologies stipulated in SANS 10103:2008 and SANS 10328:2008 (or latest versions) for residential and non -residential areas as defined in these standards.	Section 2, Section 3.3 and Section 4
A baseline description must be provided of the potential receptors and existing ambient noise levels. The receptors could include places of residence or tranquillity that have amenity value associated with low noise levels. As a minimum, this description must include the following:	
• current ambient sound levels recorded at relevant locations (e.g. receptors and proposed new noise sources) over a minimum of two nights and that provide a representative measurement of the ambient noise climate, with each sample being a minimum of ten minutes and taken at two different times of the night (such as early evening and late at night) on each night, in order to record typical ambient sound levels at these different times of night;	Section 3.3
• records of the approximate wind speed at the time of the measurement;	Section 3.3 and Appendix D
• mapped distance of the receiver from the proposed development that is the noise source; and	Section 3.1
• discussion on temporal aspects of baseline ambient conditions.	Section 3.3
Assessment of impacts done in accordance to SANS 10103:2008 and SANS 10328:2008 (or latest versions) must include the following aspects which must be considered as a minimum in the predicted impact of the proposed development:	
• characterisation and determination of noise emissions from the noise source, where characterization could include types of noise, frequency, content, vibration and temporal aspects;	Section 4.1
• projected total noise levels and changes in noise levels as a result of the construction, commissioning and operation of the proposed development for the nearest receptors using industry accepted models and forecasts; and,	Section 4.2
• desired noise levels for the area.	Section 4.2 and Section 5
The findings of the Noise Specialist Assessment must be written up in a Noise Specialist Report that must contain as a minimum the following information:	
• details and relevant qualifications and experience of the noise specialist preparing the assessment including a curriculum vitae;	Section 1.3 and Appendix A

Assessment and Reporting on Noise Impacts	Section in Report
• a signed statement of independence by the specialist;	Appendix B
• the duration and date of the site inspection and the relevance of the season and weather conditions to the outcome of the assessment;	Section 3.2 and Section 3.3
• a description of the methodology used to undertake the on-site assessment inclusive of the equipment and models used, as relevant, together with results of the noise assessment;	Section 1.6.4, Section 1.6.6 and Section 4
• a map showing the proposed development footprint (including supporting infrastructure) with a 50m buffered development envelope;	Figure 2 and Figure 3
• confirmation from the specialist that all reasonable measures have been considered, or not, in the micro- siting of the proposed development to minimise disturbance of receptors;	The site layout was provided for the assessment. Siting recommendations are provided in 6.1.4.
• a substantiated statement from the specialist on the acceptability, or not, of the proposed development and a recommendation on the approval, or not, of the proposed development;	Section 7
• any conditions to which this statement is subjected;	Section 6 and Section 7
• the assessment must identify alternative development footprints within the preferred site which would be of a "low" sensitivity as identified by the screening tool and verified through the site sensitivity verification and which were not considered;	Section 4. No alternative development footprints were provided for the assessment.
• a motivation must be provided if there were development footprints identified as per paragraph 2.5.9. above that were identified as having a "low" noise sensitivity and that were not considered appropriate;	Not applicable
• where identified, proposed impact management outcomes, mitigation measures for noise emissions during the construction and commissioning phases that may be of relative short duration, or any monitoring requirements for inclusion in the Environmental Management Programme (EMPr); and,	Section 6
• a description of the assumptions made and any uncertainties or gaps in knowledge or data.	Section 1.7

3 Description of the Receiving Environment

This chapter provides details of the receiving acoustic environment which is described in terms of:

- Local NSRs;
- The local environmental noise propagation and attenuation potential; and
- Current noise levels and the existing acoustic climate.

3.1 Noise Sensitive Receptors

Noise sensitive receptors generally include places of residence and areas where members of the public may be affected by noise generated by the project.

As mentioned in Section 1.5.4, the impact of an intruding industrial/mining noise on the environment rarely extends over more than 5 km from the source. Potential noise sensitive receptors within the project area (indicated in Figure 6), include residential areas (i.e. Winnaarshoek, Diphale and Galane). Residential areas further from the project activities, but not likely to be impacted, include Ga Makhwae and Bothashoek and areas of industrial activities.

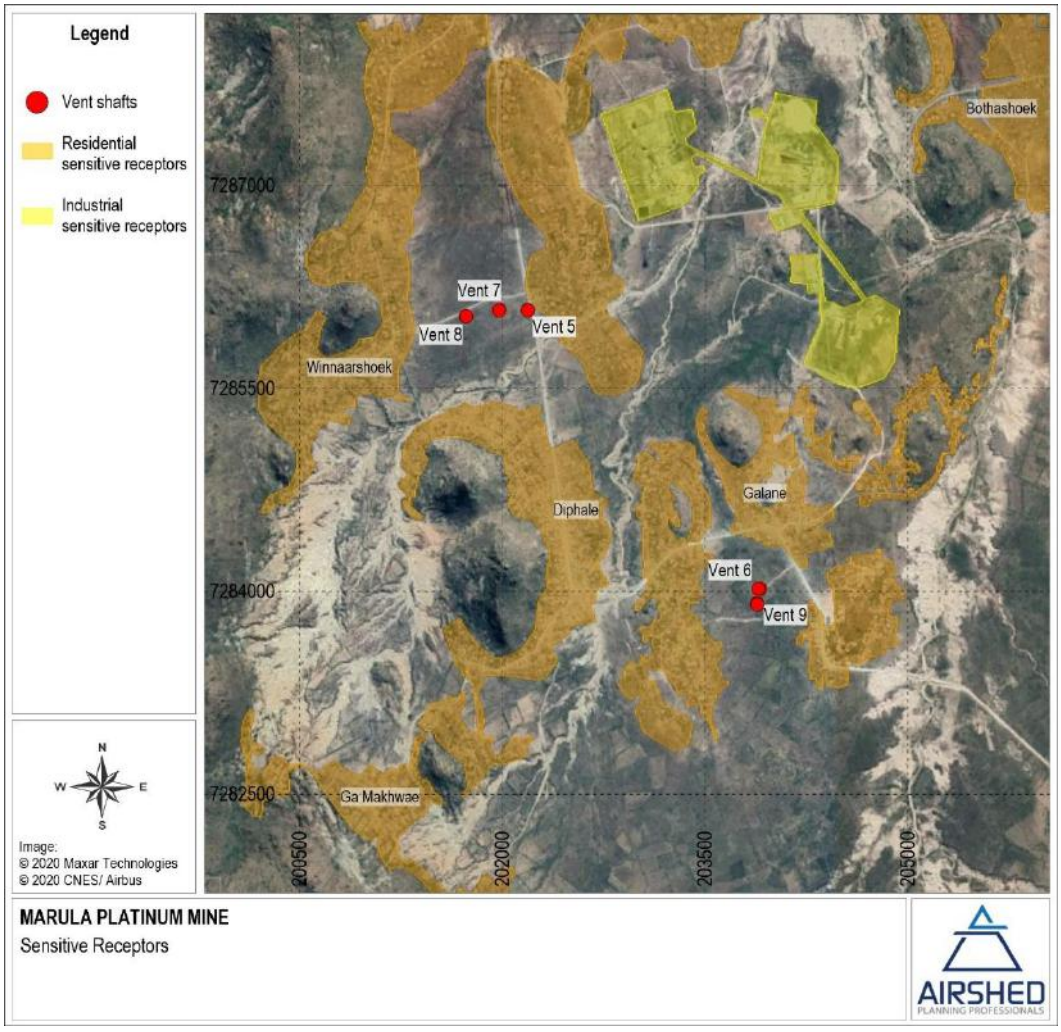


Figure 6: Sensitive receptors within the study area

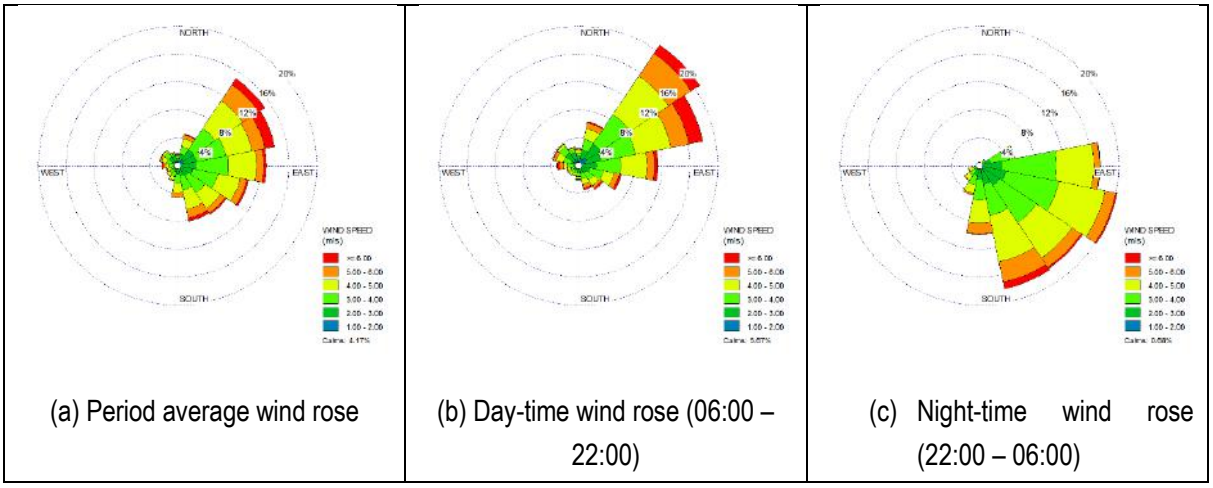
3.2 Environmental Noise Propagation and Attenuation potential

3.2.1 Atmospheric Absorption and Meteorology

Atmospheric absorption and meteorological conditions have already been mentioned with regards to their role in the propagation of noise from a source to receiver (Section 1.5.4). The main meteorological parameters affecting the propagation of noise include wind speed, wind direction and temperature. These along with other parameters such as relative humidity, air pressure, solar radiation and cloud cover affect the stability of the atmosphere and the ability of the atmosphere to absorb sound energy.

Wind speed increases with altitude, resulting in the 'bending' of the path of sound to 'focus' it on the downwind side and creating a 'shadow' on the upwind side of the source. Depending on the wind speed, the downwind level may increase by a few dB but the upwind level can drop by more than 20 dB (Brüel & Kjær Sound & Vibration Measurement A/S, 2000). It should be noted that at wind speeds of more than 5 m/s, ambient noise levels are mostly dominated by wind generated noise.

Weather Research and Forecasting (MM5)[1] data for the period 2008 to 2010 was used for the assessment. The modelled data set indicates wind flow primarily from the eastern sector (Figure 7 (a)). During the day, the predominant wind direction is from the northeast sector while during the night the predominant wind direction is from the south eastern sector. On average, noise impacts are expected to be more notable to the northwest and west of the project activities during the night and to the southwest and west of the project activities during the day.



(a) Period average wind rose | (b) Day-time wind rose (06:00 – 22:00) | (c) Night-time wind rose (22:00 – 06:00)

Figure 7: Wind rose for MM5 data, 1 January 2008 to 31 December 2010

Temperature gradients in the atmosphere create effects that are uniform in all directions from a source. On a sunny day with no wind, temperature decreases with altitude and creates a 'shadowing' effect for sounds. On a clear

[1]The MM5 (short for Fifth-Generation Penn State/NCAR Mesoscale Model) is a regional mesoscale model used for creating weather forecasts and climate projections. It is a community model maintained by Penn State University and the National Center for Atmospheric Research. The MM5 is a limited-area, terrain-following sigma coordinate model that is used to replicate or forecast mesoscale and regional scale atmospheric circulation.

night, temperatures may increase with altitude thereby 'focusing' sound on the ground surface. Noise impacts are therefore generally more notable during the night (Figure 8).

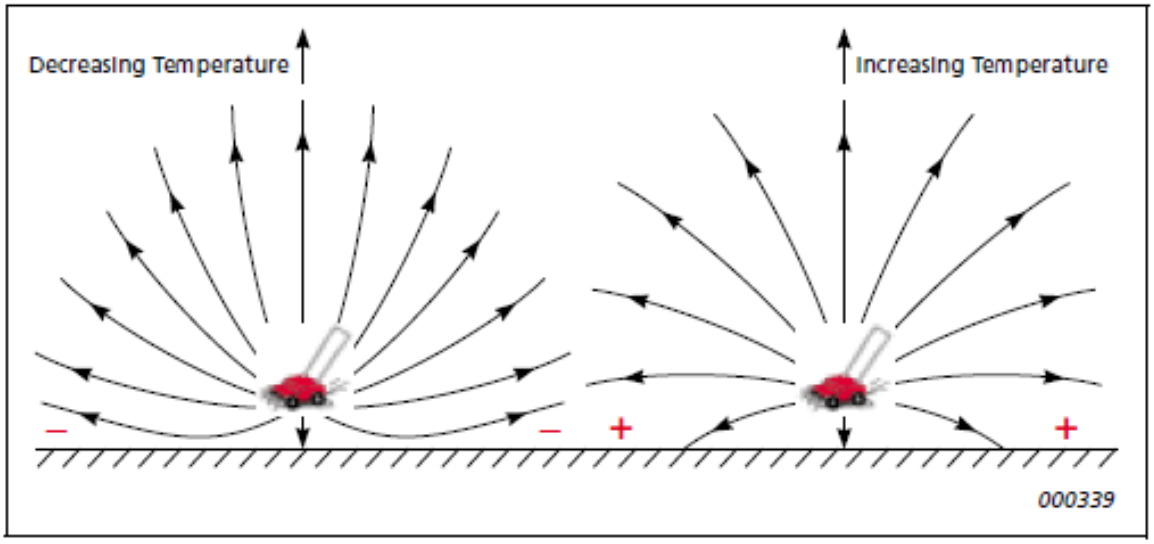


Figure 8: Bending the path of sound during typical day time conditions (image provided on the left) and night-time conditions (image provided on the right)

3.2.2 Terrain, Ground Absorption and Reflection

Noise reduction caused by a barrier (i.e. natural terrain, installed acoustic barrier, building) feature depends on two factors namely: the path difference of a sound wave as it travels over the barrier compared with direct transmission to the receiver and the frequency content of the noise (Brüel & Kjær Sound & Vibration Measurement A/S, 2000). The topography for the study area is provided in Figure 9.

Sound reflected by the ground interferes with the directly propagated sound. The effect of the ground is different for acoustically hard (e.g., concrete or water), soft (e.g., grass, trees or vegetation) and mixed surfaces. Ground attenuation is often calculated in frequency bands to take into account the frequency content of the noise source and the type of ground between the source and the receiver (Brüel & Kjær Sound & Vibration Measurement A/S, 2000). Based on observations made during the visit to site, ground cover was found to be acoustically mixed.

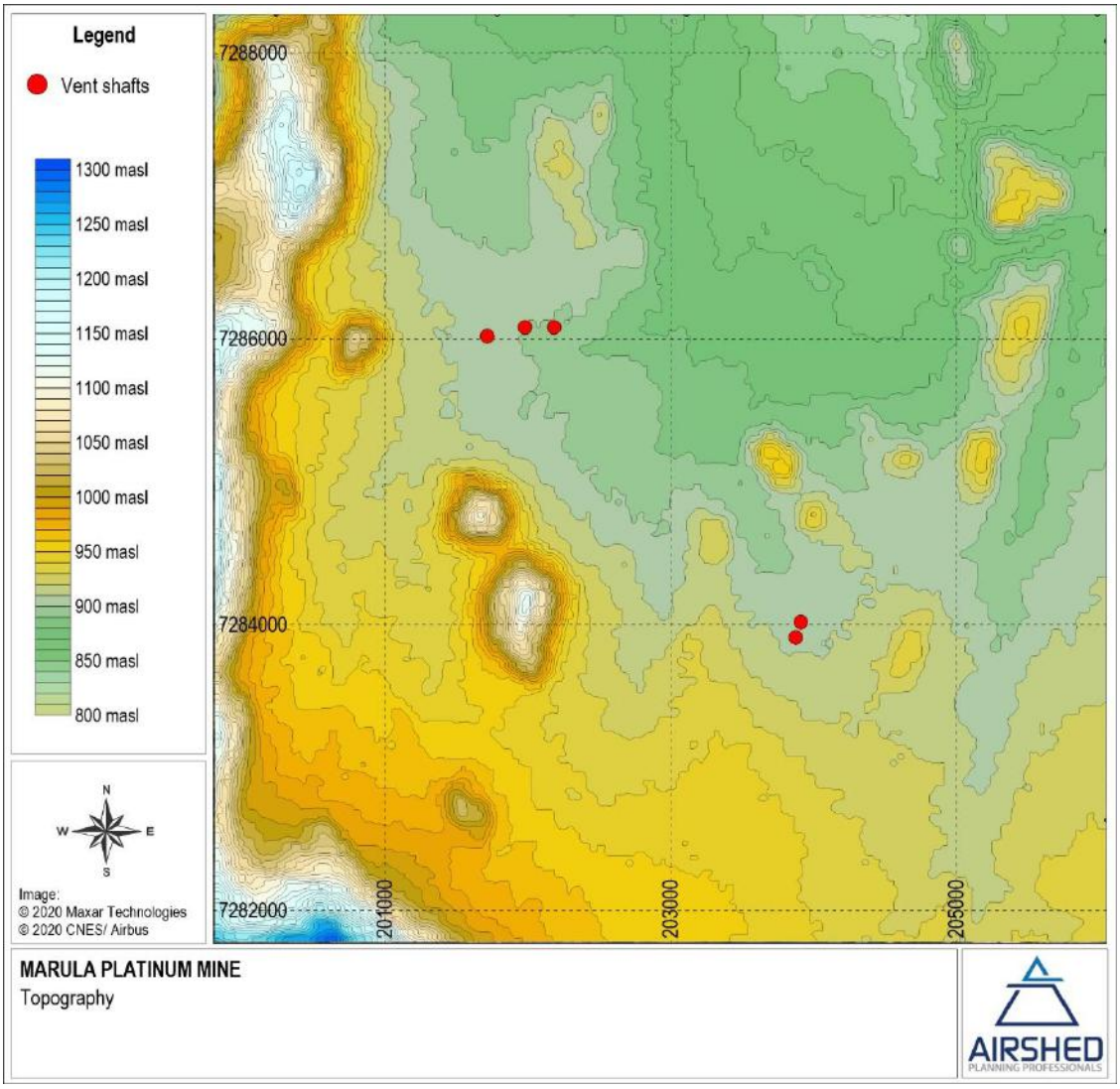


Figure 9: Topography for the study area

3.3 Baseline Noise Survey and Results

Sampling points were selected based on proposed project activities and position of sensitive receptors (Figure 10). Survey results for the campaign undertaken on 17 and 18 August 2020 are summarised in Table 7 and for comparison purposes, visually presented in Figure 11 (day-time results) and Figure 12 (night-time results).

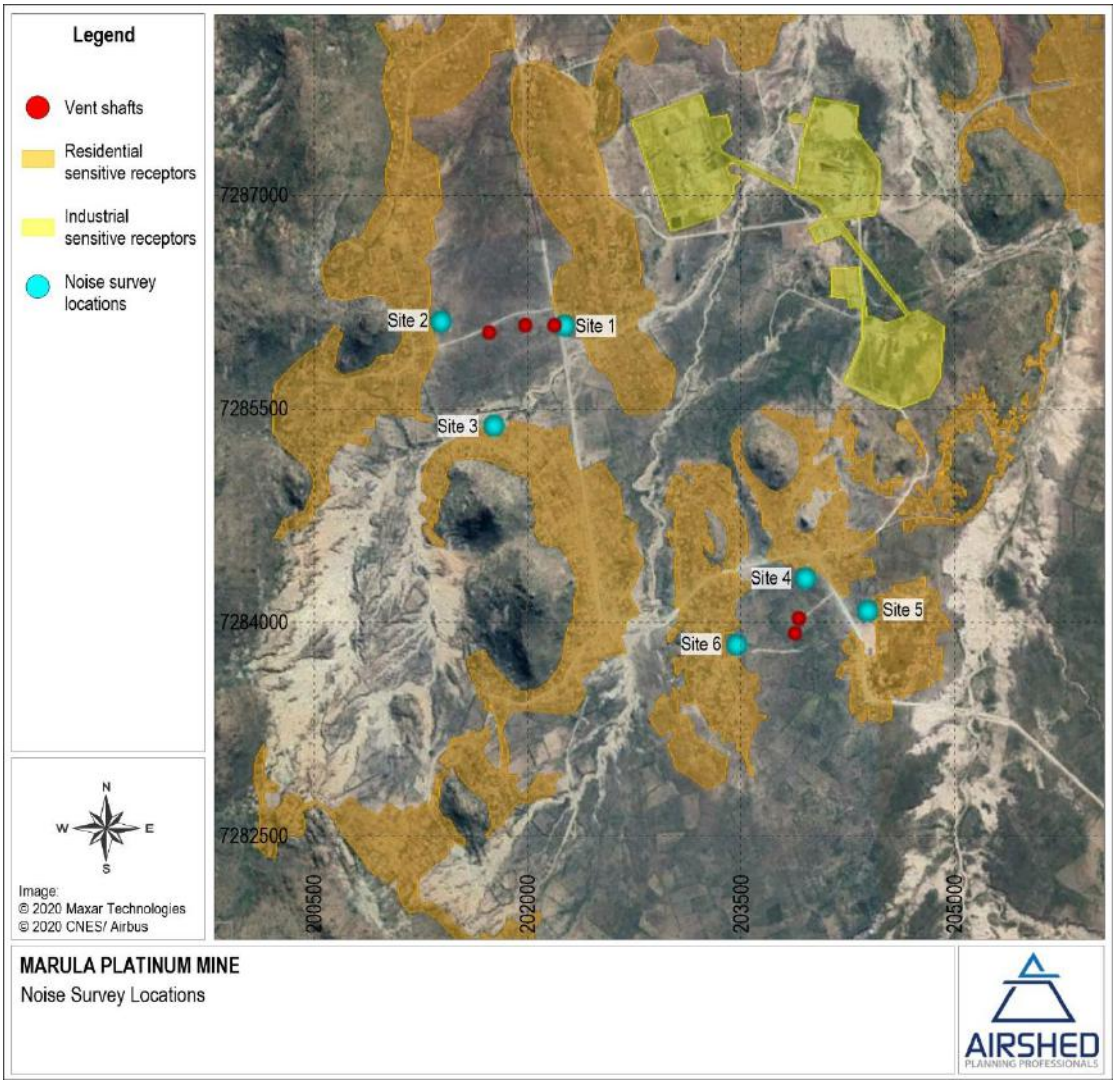


Figure 10: Locations of environmental baseline noise survey sites

The following is noted:

- Measurements were conducted on 17 and 18 August 2020.
- Weather conditions:
    - During the day (06:00-22:00), weather conditions were as follows:
        - Mid-day measurements on 17 August 2020 consisted of cloudy skies with temperatures between 17.6°C and 20.2°C. Slight to moderate wind conditions (including gusts) with wind speeds between 1.1 and 6 m/s from the northerly direction, prevailed.
        - Evening measurements on 17 August 2020 consisted of cloudy skies with temperatures between 22.4°C and 25.1°C. Slight to moderate wind conditions with wind speeds between 1 and 4.1 m/s from the south easterly direction, prevailed.
        - Evening measurements on 18 August 2020 consisted of cloudless skies with temperatures between 21°C and 24°C. Slight to moderate wind conditions with wind speeds between 1 and 3 m/s from the southerly direction, prevailed.
    - During the night (22:00-06:00), weather conditions were as follows:

        - Night-time measurements on 17 August 2020 consisted of cloudless skies with temperatures between 16.9°C and 18°C. Slight wind conditions with wind speeds between 0.1 and 1.9 m/s from the south easterly direction, prevailed.
        - Night-time measurements on 18 August 2020 consisted of cloudless skies with temperatures between 16.8°C and 19°C. Slight wind conditions with wind speeds between 0.1 and 1.4 m/s from the southerly direction, prevailed.
- Day-time baseline noise levels:
    - Measurements indicate day-time ambient noise levels that are influenced by vehicles, mining operations and community activity.
    - L_{Aeq}'s ranged between 40 dBA and 46 dBA which is considered typical of rural areas according to SANS 10103.
    - Recorded L_{Aeq}'s during the day were within IFC guidelines for residential, institutional and educational receptors (55 dBA).
- Night-time baseline noise levels:
    - Measurements indicate night-time ambient noise levels that are influenced by vehicles, mining operations and community activity.
    - L_{Aeq}'s ranged between 27 dBA and 39 dBA which is considered typical of rural to suburban areas according to SANS 10103.
    - Recorded L_{Aeq}'s during the night were within IFC guidelines for residential, institutional and educational receptors (45 dBA).

For detailed time-series, frequency spectra and statistical results, the reader is referred to Appendix E. Field log sheets containing weather records and a summary of events recorded during the measurements are included in Appendix D.

Ambient baseline noise levels for all noise sampling surveys conducted in the study area are provided in Figure 13. In order to illustrate the increase in ambient noise levels as a result of the project, the following representative background noise levels (based on an average of the survey measurements) were used:

- $L_{Req,d}$ – 43 dBA; and,
- $L_{Req,n}$ – 33.8 dBA.

Table 7: Project baseline environmental noise survey results summary

Site	Date	Duration (minutes)	L_{AFmax} (dBA)	L_{AIeq} (dBA)	L_{Aeq} (dBA)	L_{AF90} (dBA)	Observations
Day-time (06:00 – 22:00)							
Site 1	17/08/2020 9:42	30	63.2	50.0	45.6	37.7	Semi cultivated open land near road with community activity, mining activities and vehicles.
Site 2	17/08/2020 10:27	30	62.6	47.0	39.7	32.2	Gusty winds throughout the measurements, with birds audible.
Site 3	17/08/2020 11:19	30	65.7	47.0	41.4	36.3	Gusty winds throughout the measurements, traffic from the road and brick plant activities audible.
Site 4	17/08/2020 12:09	30	66.2	46.9	39.8	32.0	Vehicles and community activities audible.
Site 5	17/08/2020 12:56	30	75.5	53.6	43.1	32.6	Open land with lots of trees and shrubs. Vehicles, community activity and birds audible.
Site 6	17/08/2020 13:40	30	64.6	46.5	38.3	29.9	Goats, birds and vehicles audible.
Site 1	17/08/2020 18:22	10	67.2	51.3	48.0	38.4	Gusty winds throughout the measurements, with vehicles audible.
Site 2	17/08/2020 18:39	10	63.5	48.6	44.7	30.0	Gusty winds throughout the measurements, with community activity and vehicles audible.
Site 3	17/08/2020 18:58	10	63.9	44.6	41.1	26.3	Vehicles audible.
Site 4	17/08/2020 19:19	10	74.6	54.0	39.2	22.8	Vehicles audible.
Site 5	17/08/2020 19:35	10	62.0	45.8	42.5	31.9	Insects and vehicles audible.
Site 6	17/08/2020 19:52	10	59.9	41.8	30.7	21.4	Insects and community activity audible.
Site 1	18/08/2020 18:50	10	65.7	47.8	45.9	32.2	Existing vent shaft, vehicles and mining operations audible.

Site	Date	Duration (minutes)	L_{AFmax} (dBA)	L_{Aleq} (dBA)	L_{Aeq} (dBA)	L_{AF90} (dBA)	Observations
Site 2	18/08/2020 19:21	10	65.2	48.8	43.3	27.7	Birds, insects, barking dogs, community activity and vehicles audible.
Site 3	18/08/2020 19:45	10	62.6	46.2	43.7	29.6	Barking dogs, generator to pump water for the community, vehicles and birds audible.
Site 4	18/08/2020 19:13	10	69.3	48.7	45.3	34.1	Existing shaft vents, vehicles and barking dogs audible.
Site 5	18/08/2020 19:33	10	64.5	48.7	45.3	35.9	Barking dogs, birds, vehicles and insects audible.
Site 6	18/08/2020 19:05	10	66.8	51.2	43.7	30.0	Barking dogs, vehicles and insects audible.
Night-time (22:00 – 06:00)							
Site 1	17/08/2020 22:28	10	50.6	38.4	33.5	27.7	Vehicles and barking dogs audible.
Site 2	17/08/2020 22:52	10	51.7	37.2	31.0	25.2	Community activity, birds and vehicles audible.
Site 3	17/08/2020 23:15	10	45.1	32.6	29.0	25.4	Vehicles, insects, and generator for pumping water audible.
Site 4	17/08/2020 23:40	10	60.5	47.0	41.6	28.8	Barking dogs, mining activities and vehicles audible.
Site 5	18/08/2020 00:02	10	49.1	32.8	25.7	21.1	Community activity, birds and insects audible.
Site 6	18/08/2020 00:21	10	50.8	34.9	24.5	19.2	Community activity audible.
Site 1	18/08/2020 22:07	10	59.4	40.6	36.6	21.8	Barking dogs, mining activities, vehicles, birds and insects audible.
Site 2	18/08/2020 22:38	10	59.6	39.8	28.6	18.8	Barking dogs, chickens, vehicles, birds and insects audible.
Site 3	18/08/2020 22:10	10	55.8	35.5	24.9	18.5	Barking dogs, insects, birds and mining activity audible.

Site	Date	Duration (minutes)	L_{AFmax} (dBA)	L_{Aleq} (dBA)	L_{Aeq} (dBA)	L_{AF90} (dBA)	Observations
Site 4	18/08/2020 22:45	10	47.8	34.3	26.9	19.1	Vehicles and mining activity audible.
Site 5	18/08/2020 23:15	10	57.6	39.9	34.2	23.8	Birds and vehicles audible.
Site 6	18/08/2020 23:55	10	54.6	36.7	29.0	20.0	Vehicles and insects audible.

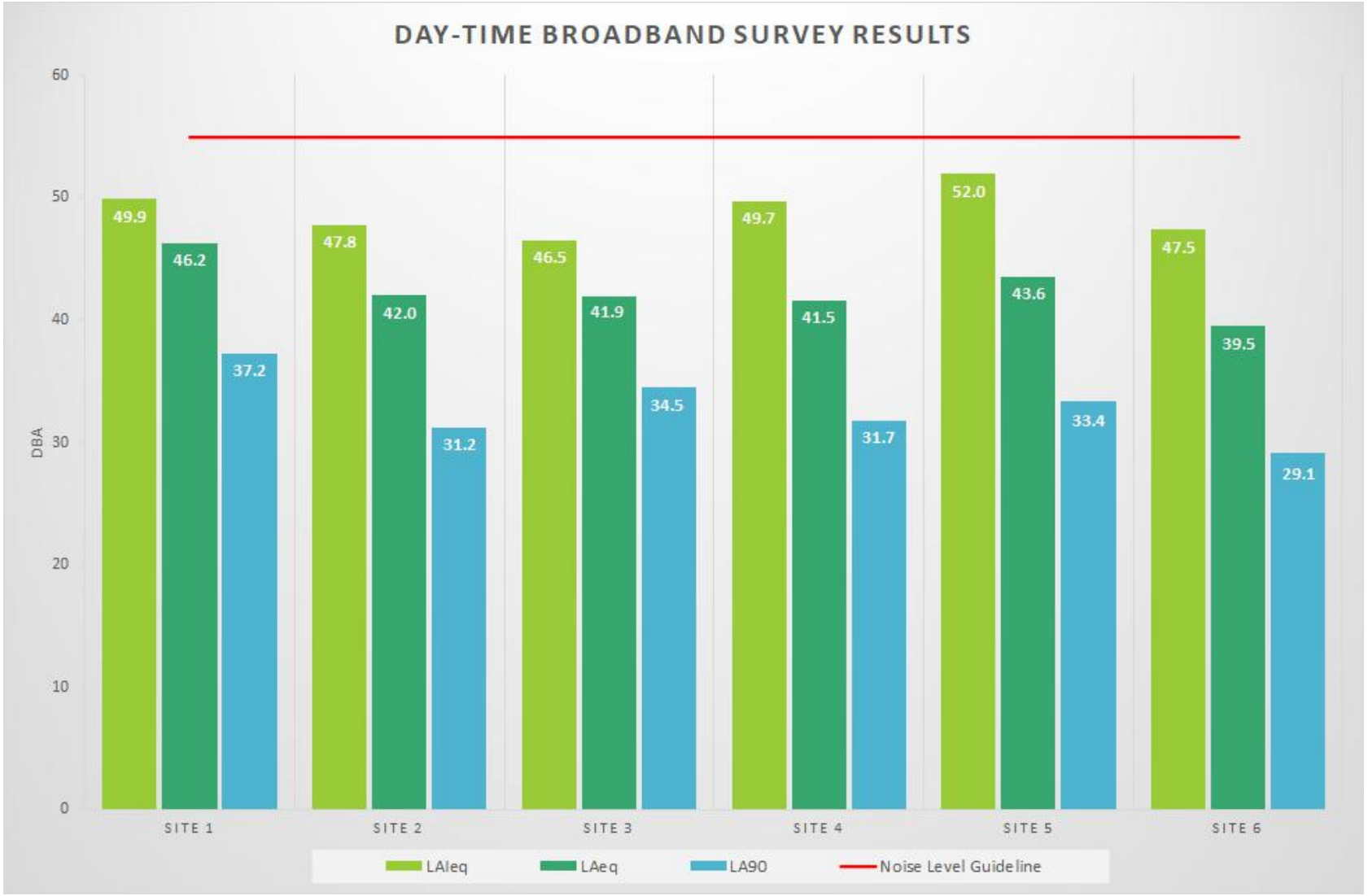


Figure 11: Day-time broadband survey results

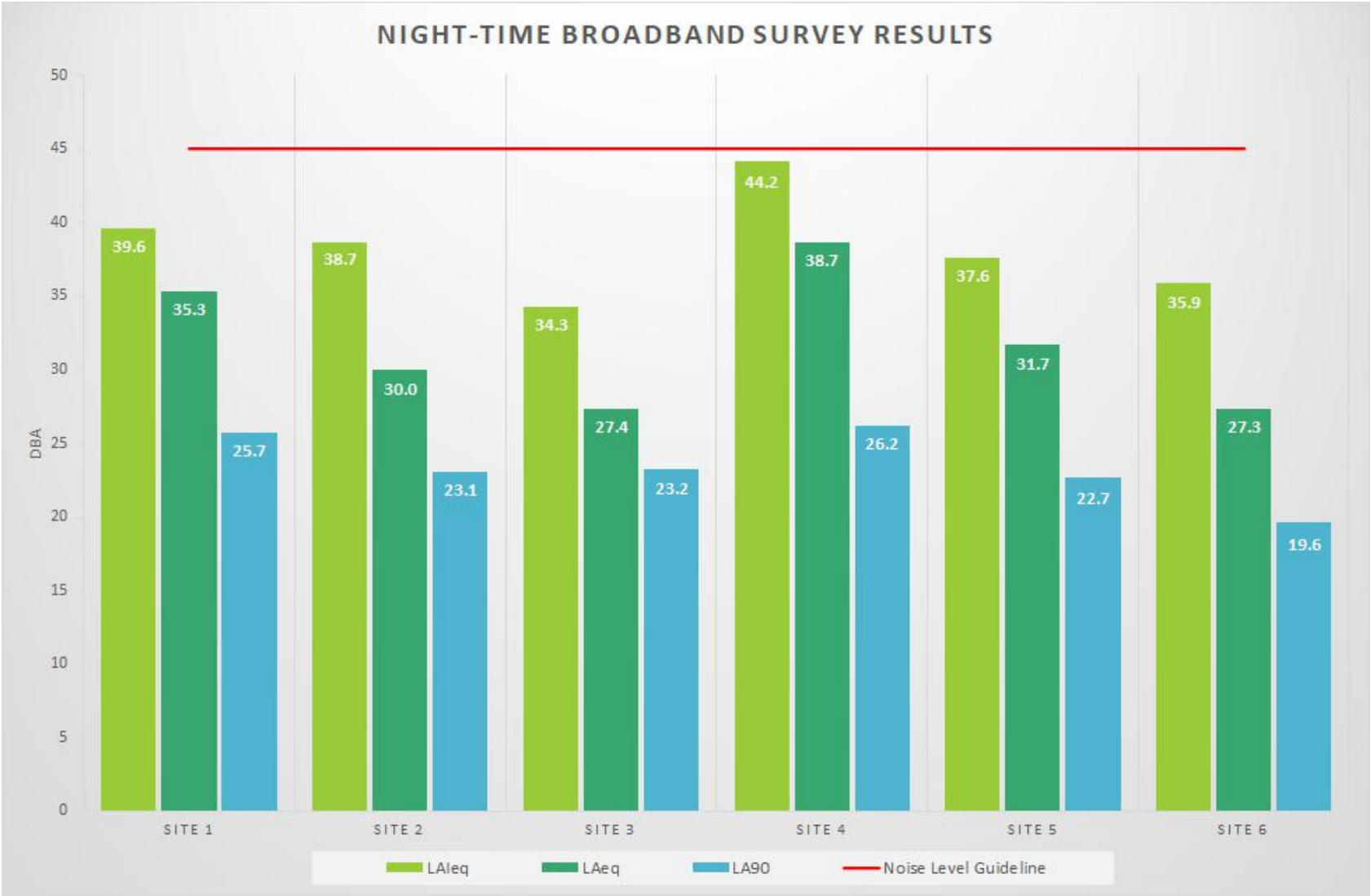


Figure 12: Night-time broadband survey results

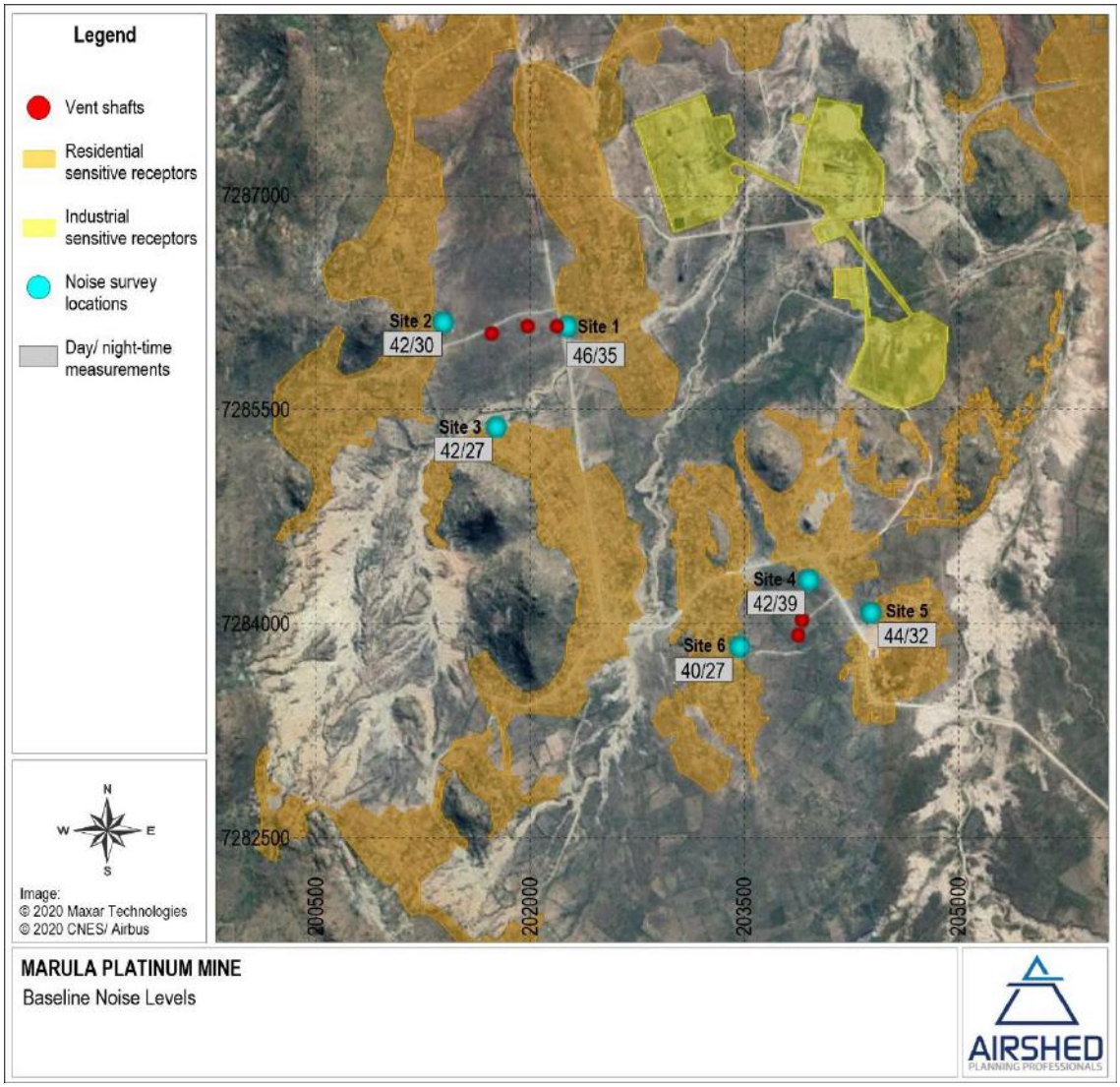


Figure 13: Average baseline noise levels

4 Impact Assessment

The noise source inventory, noise propagation modelling and results are discussed in Section 4.1 and Section 4.2 respectively.

4.1 Noise Sources and Sound Power Levels

A list of equipment (Table 8 and Table 9) was provided for the project which included pumps, fans, etc. Noise sound pressure levels were calculated for all the equipment with the total octave band frequency spectra L_W's provided in Table 10 and Table 11. The directivity of the vents is provided in Table 12.

Table 8: List of equipment for the Driekop complex

Description	Duty	Other Details	Motor Size (kW)	Poles	Run/ Stand-by (Sby)	Run (kW)
Refrigeration Plant						
Lead Configuration						
Refrigeration Machine Compressor	5.0 MW thermal	Centrifugal, R134a	1340	2	Run	1111
Lag Configuration						
Refrigeration Machine Compressor	5.0 MW thermal	Centrifugal, R134a	1340	2	Run	1111
Plantroom Overhead Crane	12.5-ton		15	4	Run	10
Bulk Air Cooler Circuit						
BAC-03 Circuit						
BAC-03 Return Pump No. 1	212 l/s @ 485 kPa	End suction	185	4	Run	129
BAC-03 Return Pump No. 2	212 l/s @ 485 kPa	End suction	185	4	Sby	0
BAC-03 Respray Pump No. 1	210 l/s @ 305 kPa	End suction	110	4	Run	80
Condenser Cooling Towers						
CCT No. 1	6.3 MW thermal	Induced draft, counter flow				
Fan No. 1		Prefabricated	185	6	Run	142
CCT No. 1	6.3 MW thermal	Induced draft, counter flow				
Fan No. 1		Prefabricated	185	6	Run	142
Condenser Circuit						
CCT Pump No. 1	248 l/s @ 350 kPa	End suction	90	4	Run	71
CCT Pump No. 2	248 l/s @ 350 kPa	End suction	90	4	Run	71
CCT Pump No. 3	248 l/s @ 350 kPa	End suction	90	4	Sby	0
Bulk Air Coolers						
BAC	8.8 MW thermal					
BAC Fan No. 1	125 m³/s @ 650 Pa	Axial	150	6	Run	124

Description	Duty	Other Details	Motor Size (kW)	Poles	Run/ Stand-by (Sby)	Run (kW)
BAC Fan No. 2	125 m³/s @ 650 Pa	Axial	150	6	Run	124
Waste Water Pump						
Waste Water Sump Pump No. 1			8	4	Run	6
Surface Main Fans						
Main Fan No. 1	140 m³/s @ 3.5 kPa	Centrifugal	700	8	Run	605
Crawl	5-ton		5	4	Run	4
Main Fan No. 2	140 m³/s @ 3.5 kPa	Centrifugal	700	8	Run	605
Crawl	5-ton		5	4	Run	4
Motor			700	8	Run	700

Table 9: List of equipment for the Clapham complex

Description	Duty	Other Details	Motor Size (kW)	Poles	Run/ Sby	Run (kW)
Refrigeration Plant						
Lead Configuration						
Refrigeration Machine Compressor	5.0 MW thermal	Centrifugal, R134a	1230	2	Run	1022
Refrigeration Machine Compressor	5.0 MW thermal	Centrifugal, R134a	1230	2	Run	1022
Lag Configuration						
Refrigeration Machine Compressor	5.0 MW thermal	Centrifugal, R134a	1230	2	Run	1022
Refrigeration Machine Compressor	5.0 MW thermal	Centrifugal, R134a	1230	2	Run	1022
Plantroom Overhead Crane	12.5-ton		15	4	Run	10
Bulk Air Coolers						
BAC (no fans)	6.6 MW thermal					
BAC (no fans)	9.6 MW thermal					
Bulk Air Cooler Circuit						
BAC-01 Circuit						
BAC-01 Return Pump No. 1	137 Vs @ 65 kPa	End suction	15	6	Run	11
BAC-01 Return Pump No. 2	137 Vs @ 65 kPa	End suction	15	6	Sby	0
BAC-01 Respray Pump No. 1	135 Vs @ 300 kPa	End suction	75	4	Run	61
BAC-01 Supply Pump No. 1	135 Vs @ 310 kPa	End suction	90	4	Run	65
BAC-01 Supply Pump No. 2	135 Vs @ 310 kPa	End suction	90	4	Sby	0
BAC-02 Circuit						
BAC-02 Return Pump No. 1	125 Vs @ 45 kPa	End suction	9	6	Run	7
BAC-02 Return Pump No. 2	125 Vs @ 45 kPa	End suction	9	6	Run	7
BAC-02 Return Pump No. 3	125 Vs @ 45 kPa	End suction	9	6	Sby	0
BAC-02 Respray Pump No. 1	250 Vs @ 300 kPa	End suction	110	4	Run	85
BAC-02 Supply Pump No. 1	125 Vs @ 235 kPa	End suction	55	4	Run	42
BAC-02 Supply Pump No. 2	125 Vs @ 235 kPa	End suction	55	4	Run	42
BAC-02 Supply Pump No. 3	125 Vs @ 235 kPa	End suction	55	4	Sby	0
Evaporator Pumps No. 1	193 @ 150 kPa	End suction	55	4	Run	38

Description	Duty	Other Details	Motor Size (kW)	Poles	Run/ Sby	Run (kW)
Evaporator Pumps No. 2	193 @ 150 kPa	End suction	55	4	Run	38
Evaporator Pumps No. 3	193 @ 150 kPa	End suction	55	4	Sby	38
Condenser Cooling Towers						
CCT No. 1	5.8 MW thermal	Induced draft, counter flow				
Fan No. 1		Prefabricated	185	6	Run	131
CCT No. 2	5.8 MW thermal	Induced draft, counter flow				
Fan No. 1		Prefabricated	185	6	Run	131
CCT No. 3	5.8 MW thermal	Induced draft, counter flow				
Fan No. 1		Prefabricated	185	6	Run	131
CCT No. 4	5.8 MW thermal	Induced draft, counter flow				
Fan No. 1		Prefabricated	185	6	Run	131
Condenser Circuit						
CCT Pump No. 1	303 Vs @ 300 kPa	End suction	90	4	Run	70
CCT Pump No. 2	303 Vs @ 300 kPa	End suction	90	4	Run	70
CCT Pump No. 3	303 Vs @ 300 kPa	End suction	90	4	Run	70
CCT Pump No. 4	303 Vs @ 300 kPa	End suction	90	4	Sby	0
Waste Water Pump						
Waste Water Sump Pump No. 1			8	4	Run	6
Surface Main Fans						
Main Fan No. 1	167 m³/s @ 5.3 kPa	Centrifugal	1300	8	Run	1080
Crawl	5-ton		5	4	Run	4
Main Fan No. 2	167 m³/s @ 5.3 kPa	Centrifugal	1300	8	Run	1080
Crawl	5-ton		5	4	Run	4
Main Fan No. 3	167 m³/s @ 5.3 kPa	Centrifugal	1300	8	Run	1080
Crawl	5-ton		5	4	Run	4
Motor			1200	8	Run	1200

Table 10: Octave band frequency spectra L_W's for the project equipment at the Driekop complex

Description	Type	LW octave band frequency spectra (dB)								L_W (dB)	L_{WA} (dBA)	Source
		63	125	250	500	1000	2000	4000	8000			
Refrigeration Plant												
Lead Configuration												
Refrigeration Machine Compressor	L_W	100.5	99.5	97.5	97.5	99.5	103.5	102.5	98.5	109.4	108.4	L_W Predictions (Bruce & Moritz, 1998)
Lag Configuration												
Refrigeration Machine Compressor	L_W	100.5	99.5	97.5	97.5	99.5	103.5	102.5	98.5	109.4	108.4	L_W Predictions (Bruce & Moritz, 1998)
Plantroom Overhead Crane	L_W	81.0	77.0	66.0	62.0	59.0	57.0	51.0	46.0	82.6	66.5	Lw Database (DC)
Bulk Air Cooler Circuit												
BAC-03 Circuit												
BAC-03 Return Pump No. 1	L_W	92.1	93.1	95.1	95.1	98.1	95.1	91.1	85.1	103.3	101.7	L_W Predictions (Bruce & Moritz, 1998)
BAC-03 Respray Pump No. 1	L_W	91.5	92.5	94.5	94.5	97.5	94.5	90.5	84.5	102.7	101.0	L_W Predictions (Bruce & Moritz, 1998)
Condenser Cooling Towers												
CCT + Fan No. 1	L_W	111.5	111.5	108.5	105.5	101.5	98.5	95.5	87.5	116.2	107.7	L_W Predictions (Bruce & Moritz, 1998)
CCT + Fan No. 1	L_W	111.5	111.5	108.5	105.5	101.5	98.5	95.5	87.5	116.2	107.7	L_W Predictions (Bruce & Moritz, 1998)
Condenser Circuit												
CCT Pump No. 1	L_W	91.3	92.3	94.3	94.3	97.3	94.3	90.3	84.3	102.5	100.9	L_W Predictions (Bruce & Moritz, 1998)
CCT Pump No. 2	L_W	91.3	92.3	94.3	94.3	97.3	94.3	90.3	84.3	102.5	100.9	L_W Predictions (Bruce & Moritz, 1998)
Bulk Air Coolers												
BAC Fan No. 1	L_W	109.0	110.0	111.0	111.0	111.0	109.0	105.0	104.0	118.4	115.7	L_W Predictions (Bruce & Moritz, 1998)
BAC Fan No. 2	L_W	109.0	110.0	111.0	111.0	111.0	109.0	105.0	104.0	118.4	115.7	L_W Predictions (Bruce & Moritz, 1998)
Waste Water Pump												
Waste Water Sump Pump No. 1	L_W	76.7	77.7	79.7	79.7	82.7	79.7	75.7	69.7	87.9	86.2	L_W Predictions (Bruce & Moritz, 1998)
Surface Main Fans												
Main Fan No. 1	L_W	105.1	104.1	100.1	95.1	93.1	89.1	85.1	78.1	108.8	98.6	L_W Predictions (Bruce & Moritz, 1998)
Crawl	L_W	81.0	81.0	78.0	76.0	74.0	72.0	68.0	63.0	86.1	79.4	Lw Database (DC)
Main Fan No. 2	L_W	105.1	104.1	100.1	95.1	93.1	89.1	85.1	78.1	108.8	98.6	L_W Predictions (Bruce & Moritz, 1998)

Description	Type	LW octave band frequency spectra (dB)								Lw (dB)	LWA (dBA)	Source
		63	125	250	500	1000	2000	4000	8000			
Crawl	Lw	81.0	81.0	78.0	76.0	74.0	72.0	68.0	63.0	86.1	79.4	Lw Database (DC)
Electric Motor	Lw	91.9	93.9	93.9	94.9	91.9	88.9	82.9	73.9	100.8	96.7	Lw Predictions (Bruce & Moritz, 1998)

Table 11: Octave band frequency spectra L_W's for the project equipment at the Clapham complex

Description	Type	Lw octave band frequency spectra (dB)									Lw (dB)	LWA (dBA)	Source
		31.5	63	125	250	500	1000	2000	4000	8000			
Refrigeration Plant													
Lead Configuration													
Refrigeration Machine Compressor	Lw		100.1	99.1	97.1	97.1	99.1	103.1	102.1	98.1	109.0	108.0	Lw Predictions (Bruce & Moritz, 1998)
Refrigeration Machine Compressor	Lw		100.1	99.1	97.1	97.1	99.1	103.1	102.1	98.1	109.0	108.0	Lw Predictions (Bruce & Moritz, 1998)
Lag Configuration													
Refrigeration Machine Compressor	Lw		100.1	99.1	97.1	97.1	99.1	103.1	102.1	98.1	109.0	108.0	Lw Predictions (Bruce & Moritz, 1998)
Refrigeration Machine Compressor	Lw		100.1	99.1	97.1	97.1	99.1	103.1	102.1	98.1	109.0	108.0	Lw Predictions (Bruce & Moritz, 1998)
Plantroom Overhead Crane	Lw		81.0	77.0	66.0	62.0	59.0	57.0	51.0	46.0	82.6	66.5	Lw Database (DC)
Bulk Air Coolers													
BAC (no fans)	Lw			105	104	106	108	110	112	110	117.1	116.9	Lw Predictions (Bruce & Moritz, 1998)
BAC (no fans)	Lw			105	104	106	108	110	112	110	117.1	116.9	Lw Predictions (Bruce & Moritz, 1998)
Bulk Air Cooler Circuit													
BAC-01 Circuit													
BAC-01 Return Pump No. 1	Lw		83.2	84.2	86.2	86.2	89.2	86.2	82.2	76.2	94.4	92.7	Lw Predictions (Bruce & Moritz, 1998)
BAC-01 Respray Pump No. 1	Lw		91.1	92.1	94.1	94.1	97.1	94.1	90.1	84.1	102.3	100.7	Lw Predictions (Bruce & Moritz, 1998)
BAC-01 Supply Pump No. 1	Lw		84.9	85.9	87.9	87.9	90.9	87.9	83.9	77.9	96.1	94.4	Lw Predictions (Bruce & Moritz, 1998)
BAC-02 Circuit													

Description	Type	Lw octave band frequency spectra (dB)									Lw (dB)	LwA (dBA)	Source
		31.5	63	125	250	500	1000	2000	4000	8000			
BAC-02 Return Pump No. 1	Lw		81.2	82.2	84.2	84.2	87.2	84.2	80.2	74.2	92.4	90.8	Lw Predictions (Bruce & Moritz, 1998)
BAC-02 Return Pump No. 2	Lw		81.2	82.2	84.2	84.2	87.2	84.2	80.2	74.2	92.4	90.8	Lw Predictions (Bruce & Moritz, 1998)
BAC-02 Respray Pump No. 1	Lw		91.6	92.6	94.6	94.6	97.6	94.6	90.6	84.6	102.8	101.1	Lw Predictions (Bruce & Moritz, 1998)
BAC-02 Supply Pump No. 1	Lw		89.0	90.0	92.0	92.0	95.0	92.0	88.0	82.0	100.2	98.6	Lw Predictions (Bruce & Moritz, 1998)
BAC-02 Supply Pump No. 2	Lw		89.0	90.0	92.0	92.0	95.0	92.0	88.0	82.0	100.2	98.6	Lw Predictions (Bruce & Moritz, 1998)
Evaporator Pumps No. 1	Lw		88.6	89.6	91.6	91.6	94.6	91.6	87.6	81.6	99.8	98.1	Lw Predictions (Bruce & Moritz, 1998)
Evaporator Pumps No. 2	Lw		88.6	89.6	91.6	91.6	94.6	91.6	87.6	81.6	99.8	98.1	Lw Predictions (Bruce & Moritz, 1998)
Evaporator Pumps No. 3	Lw		88.6	89.6	91.6	91.6	94.6	91.6	87.6	81.6	99.8	98.1	Lw Predictions (Bruce & Moritz, 1998)
Condenser Cooling Towers													
CCT + Fan No. 1	Lw		111.2	111.2	108.2	105.2	101.2	98.2	95.2	87.2	115.8	107.4	Lw Predictions (Bruce & Moritz, 1998)
CCT + Fan No. 2	Lw		111.2	111.2	108.2	105.2	101.2	98.2	95.2	87.2	115.8	107.4	Lw Predictions (Bruce & Moritz, 1998)
CCT + Fan No. 3	Lw		111.2	111.2	108.2	105.2	101.2	98.2	95.2	87.2	115.8	107.4	Lw Predictions (Bruce & Moritz, 1998)
CCT + Fan No. 4	Lw		111.2	111.2	108.2	105.2	101.2	98.2	95.2	87.2	115.8	107.4	Lw Predictions (Bruce & Moritz, 1998)
Condenser Circuit													
CCT Pump No. 1	Lw		91.3	92.3	94.3	94.3	97.3	94.3	90.3	84.3	102.5	100.9	Lw Predictions (Bruce & Moritz, 1998)
CCT Pump No. 2	Lw		91.3	92.3	94.3	94.3	97.3	94.3	90.3	84.3	102.5	100.9	Lw Predictions (Bruce & Moritz, 1998)
CCT Pump No. 3	Lw		91.3	92.3	94.3	94.3	97.3	94.3	90.3	84.3	102.5	100.9	Lw Predictions (Bruce & Moritz, 1998)
Waste Water Pump													
Waste Water Sump Pump No. 1	Lw		76.7	77.7	79.7	79.7	82.7	79.7	75.7	69.7	87.9	86.2	Lw Predictions (Bruce & Moritz, 1998)
Surface Main Fans													
Main Fan No. 1	Lw		109.5	108.5	104.5	99.5	97.5	93.5	89.5	82.5	113.1	103.0	Lw Predictions (Bruce & Moritz, 1998)
Crawl	Lw		81.0	81.0	78.0	76.0	74.0	72.0	68.0	63.0	86.1	79.4	Lw Database (DC)
Main Fan No. 2	Lw		109.5	108.5	104.5	99.5	97.5	93.5	89.5	82.5	113.1	103.0	Lw Predictions (Bruce & Moritz, 1998)
Crawl	Lw		81.0	81.0	78.0	76.0	74.0	72.0	68.0	63.0	86.1	79.4	Lw Database (DC)

Description	Type	Lw octave band frequency spectra (dB)									Lw (dB)	LwA (dBA)	Source
		31.5	63	125	250	500	1000	2000	4000	8000			
Main Fan No. 3	Lw		109.5	108.5	104.5	99.5	97.5	93.5	89.5	82.5	113.1	103.0	Lw Predictions (Bruce & Moritz, 1998)
Crawl	Lw		81.0	81.0	78.0	76.0	74.0	72.0	68.0	63.0	86.1	79.4	Lw Database (DC)
Electric Motor	Lw	88	90	92	93	93	96	96	88	81	101.8	100.6	Lw Predictions (Bruce & Moritz, 1998)

Table 12: Directivity of the vents

Source name	Number of vents at shaft	Height of Release Above Ground (m)	Diameter at Stack Tip / Vent Exit (m)	Actual Gas Exit Temperature (°C)	Actual Gas Exit Velocity (m/s)
Driekop new vents	2	10	3.66	30	14
Clapham new vents	3	10	3.66	30	17

4.2 Noise Propagation and Simulated Noise Levels

The propagation of noise generated during the operational phase was calculated with CadnaA in accordance with ISO 9613. Site specific acoustic parameters as discussed in Section 3.2 along with source data discussed in Section 4.1, were applied in the model.

As a conservative approach, buildings have not been included in the propagation modelling. Buildings (such as the refrigeration plant and motors to drive the surface fans) will provide acoustic shielding to the outside through absorption of acoustic energy and transmission losses.

Results are presented in isopleth form (Figure 14 to Figure 19). The simulated equivalent continuous day-time rating level ($L_{Req,d}$) due to project operations of 55 dBA (IFC guideline level) extends ~450 m from the project operations. The simulated equivalent continuous night-time rating level ($L_{Req,n}$) of 45 dBA (IFC guideline level) due to project operations extends ~450 m to ~730 m from the project operations.

The proposed operational phase related noise due to the project is predicted to exceed IFC guidelines at Galane during day-time hours and at Winnaarshoek and Galane during night-time hours (Table 13).

For a person with average hearing acuity an increase of less than 3 dBA in the general ambient noise level is not detectable. With the approach adopted for the assessment (detailed in Section 1.6), the predicted increase in noise levels of 3 dBA above baseline (i.e. notable increase in noise) due to the project operations are expected up to a distance of ~500 m to ~700 m (day-time) and ~1500 m (night-time) from the project operations (Figure 17 and Figure 18). In accordance with the SANS 10103, a “medium” reaction with “sporadic” complaints are expected from Winnaarshoek and Diphale during the day-time due to project operations (Table 13). “Strong” reaction is expected from Galane due to day-time project operations. “Very strong” reaction is expected from Winnaarshoek, Diphale and Galane due to night-time project operations.

The 1992 Noise Control Regulations defines a “disturbing noise” as a noise level which exceeds the zone sound level or, if no zone sound level has been designated, a noise level which exceeds the ambient sound level at the same measuring point by 7 dBA or more. The predicted increase in noise levels due to project operations at NSRs are provided in Table 13.

Table 13: Summary of simulated noise levels (provided as dBA) due to the project and baseline noise levels within the study area

Noise Sensitive Receptor	Day-time			Night-time		
	Simulated noise levels due to project operations (dBA)	Increase in noise levels above baseline[c] (dBA)	Expected Community Response due to Maximum Increase Above Baseline of more than 3 dBA[d][e]	Simulated noise levels due to project operations (dBA)	Increase in noise levels above baseline[c] (dBA)	Expected Community Response due to Maximum Increase Above Baseline of more than 3 dBA[d][e]
Winnaarshoek	52	6.8		53[b]	16.7	✓
Diphale	46	5.5		44	16.7	✓
Galane	60[a]	13.6	✓	60[b]	20.3	✓

a. Exceeds day-time IFC guideline of 55 dBA for residences.

b. Exceeds night-time IFC guideline of 45 dBA for residences.

c. Based on measurements obtained during the survey undertaken on 17 and 18 August 2020

d. Likely community response:

- 3 to 5 dBA – There will be 'little' reaction with 'sporadic complaints'.
- 5 to 10 dBA – There will be 'little' to 'medium' reaction with 'sporadic' to 'widespread' complaints.
- 10 to 15 dBA – There will be a 'strong' reaction with 'threats of community action'.
- > 15 dBA – There will be a 'very strong' reaction with 'vigorous community action'.

e. Noise levels greater than 7dBA indicated with a tick.

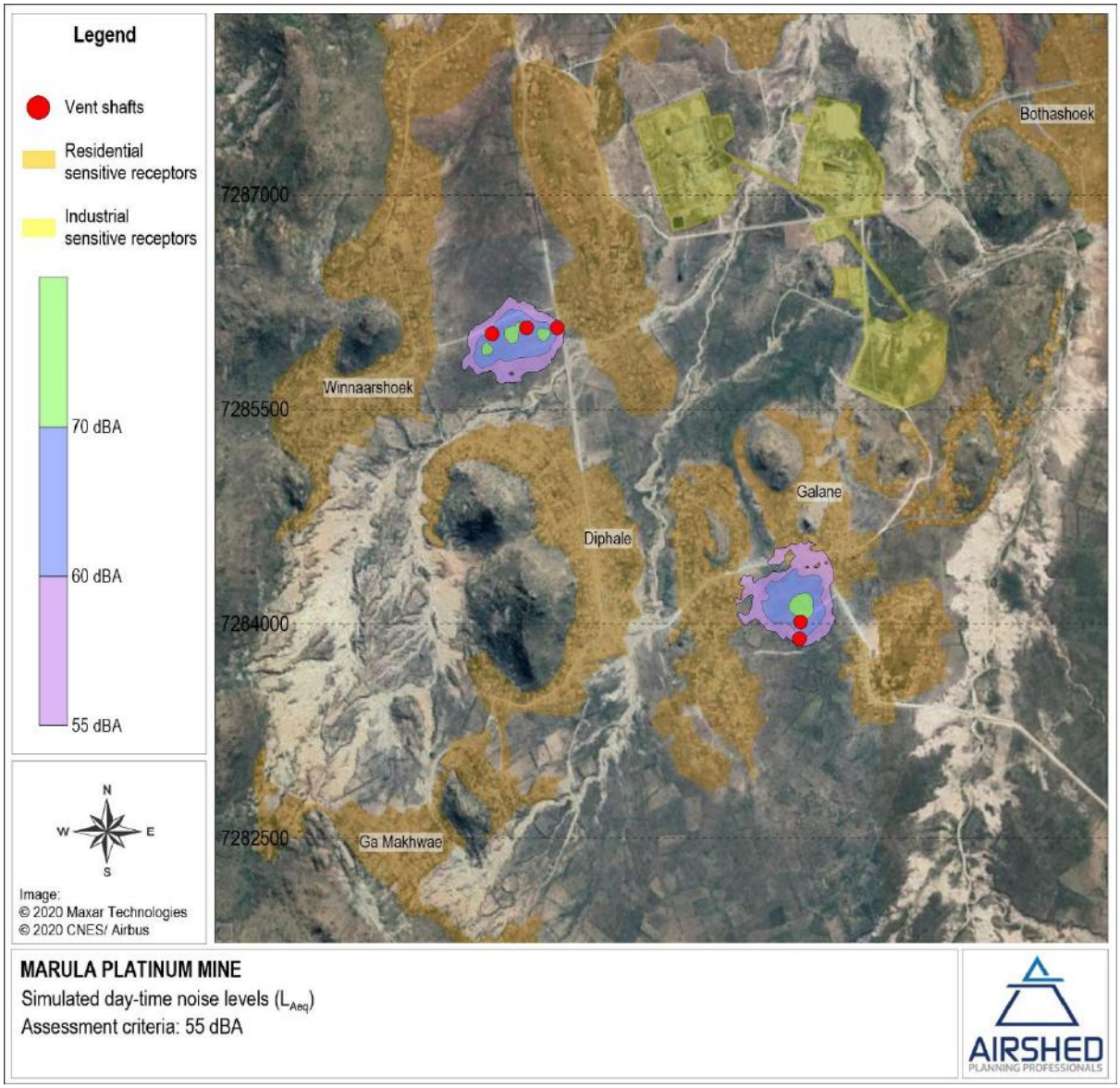


Figure 14: Simulated equivalent continuous day-time rating level ($L_{Req,d}$) for project activities

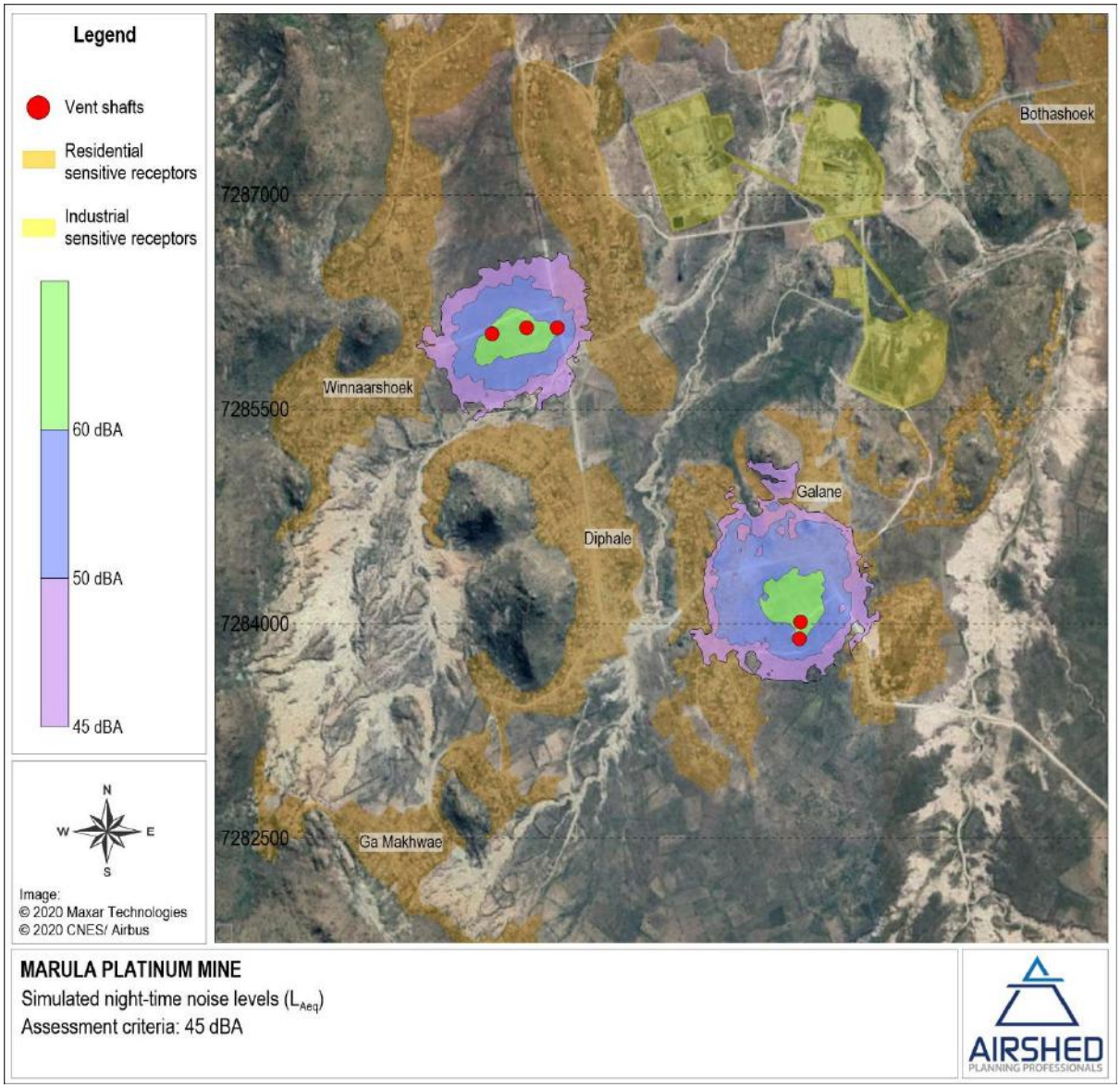


Figure 15: Simulated equivalent continuous night-time rating level ($L_{Req,n}$) for project activities

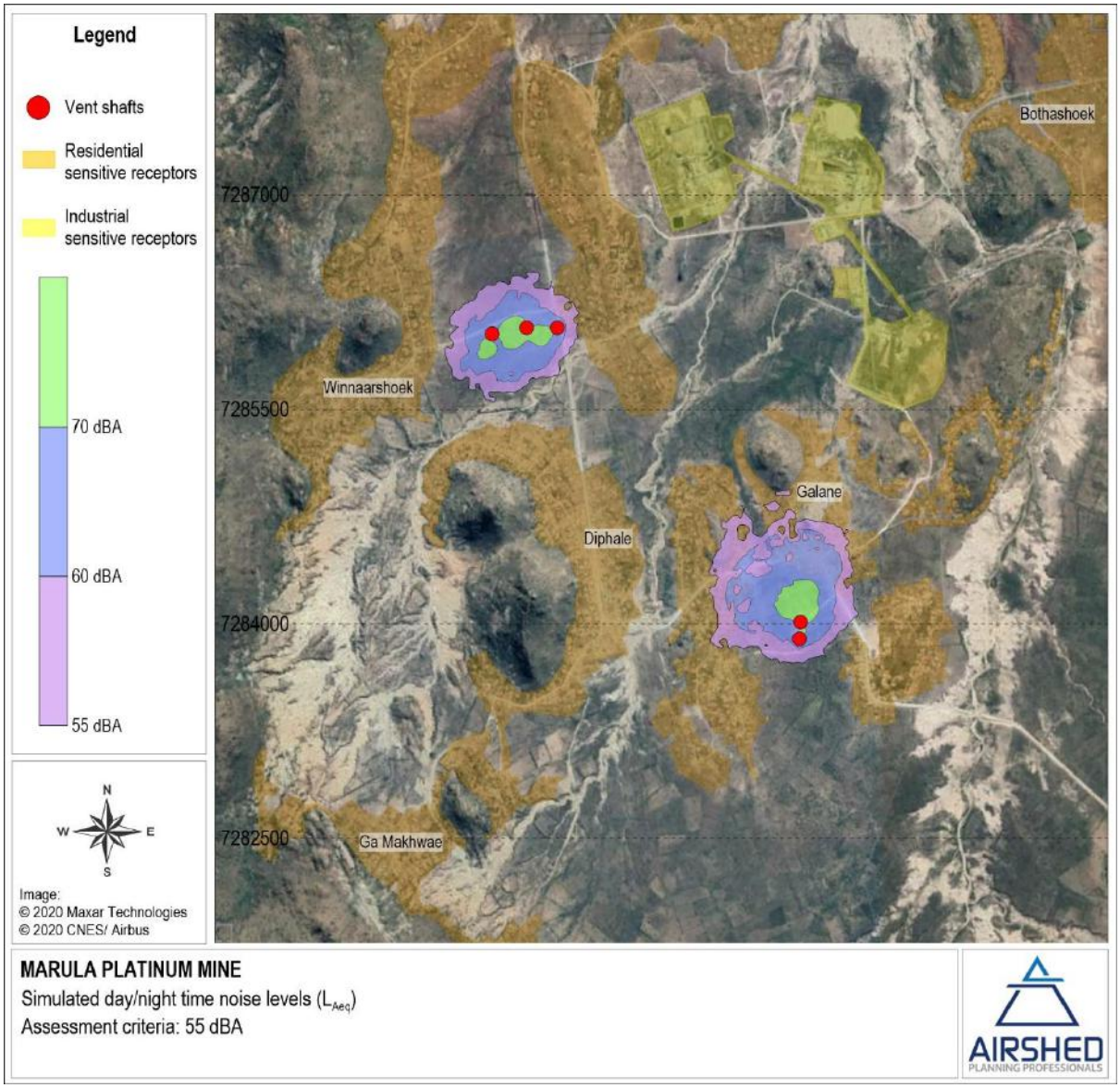


Figure 16: Simulated equivalent continuous day/night-time rating level ($L_{Req,dn}$) for project activities

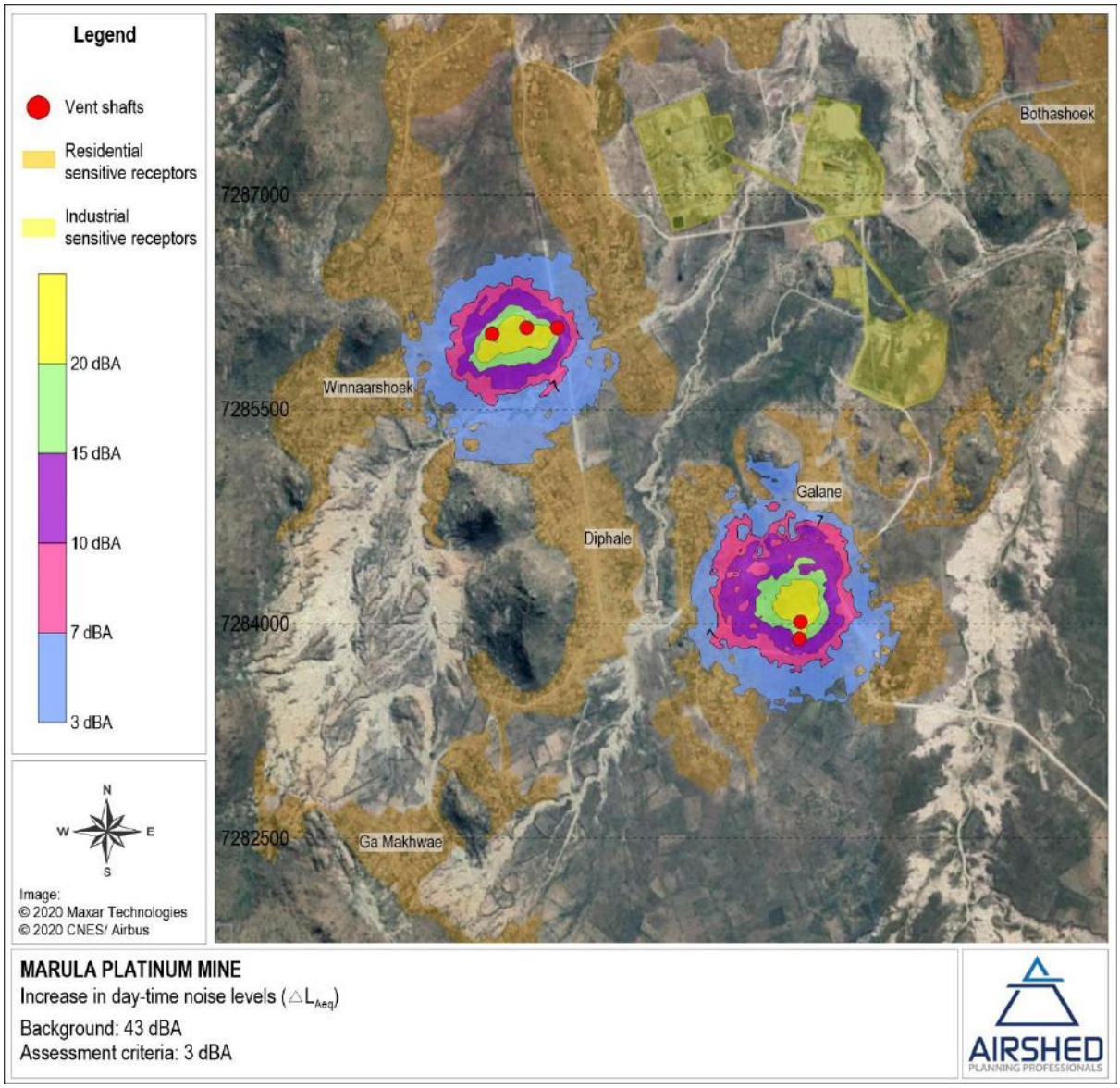


Figure 17: Simulated increase in equivalent continuous day-time rating level ($\Delta L_{Req,d}$) above the baseline

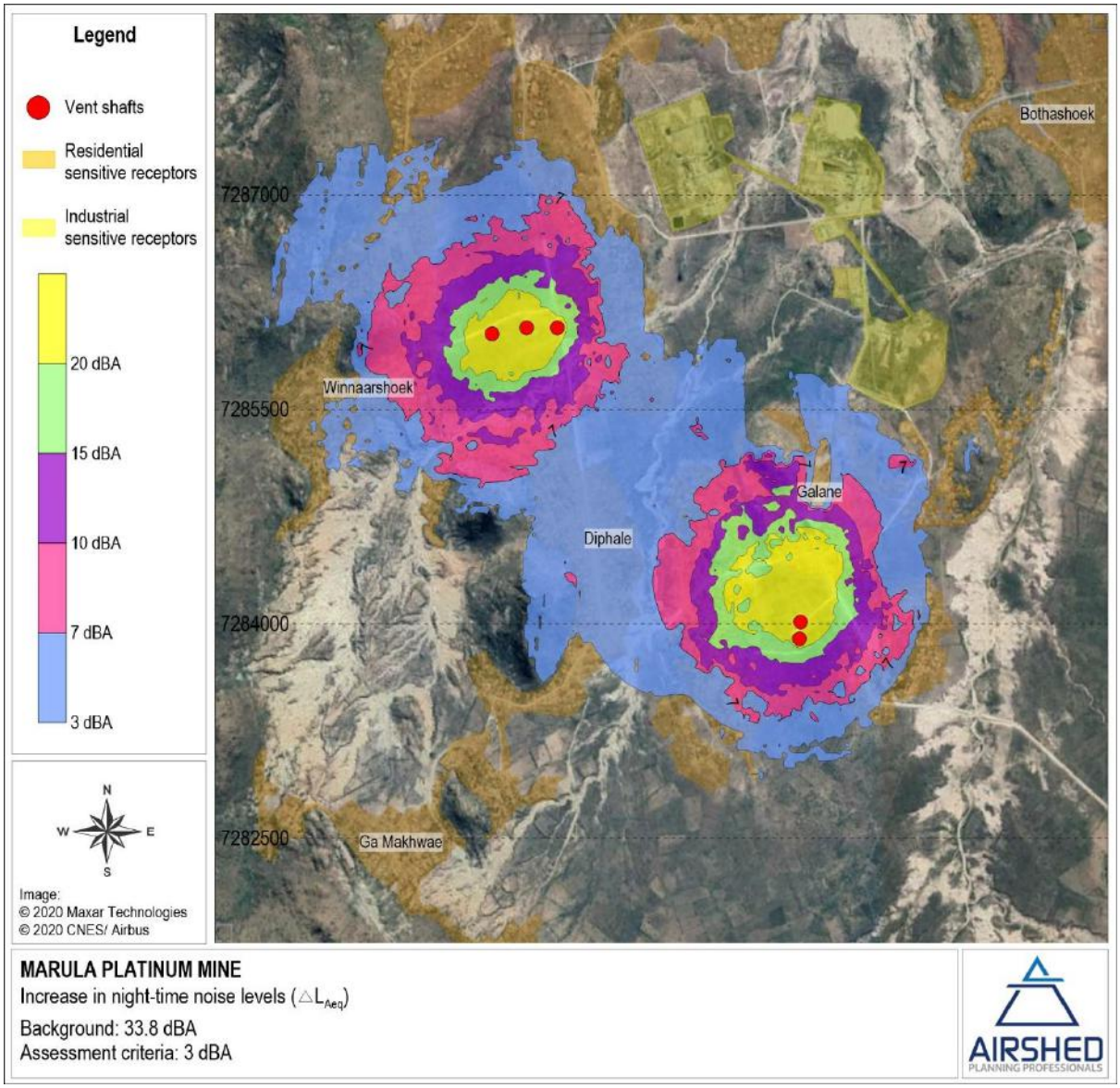


Figure 18: Simulated increase in equivalent continuous night-time rating level ($\Delta L_{Req,n}$) above the baseline

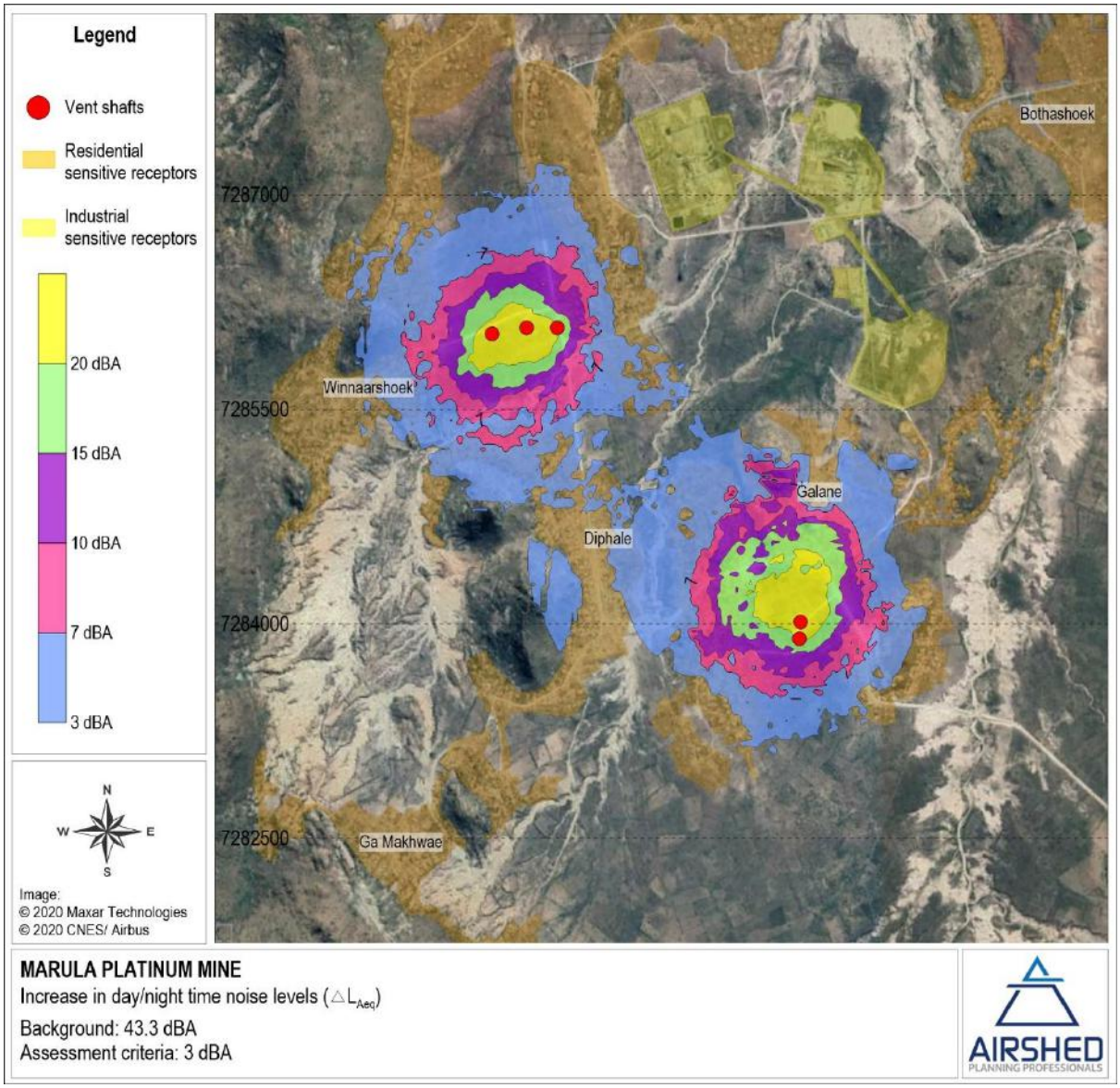


Figure 19: Simulated increase in equivalent continuous day/night-time rating level ($\Delta L_{Req,dn}$) above the baseline

5 Impact Significance Rating

The significance of environmental noise impacts was assessed according to the methodology adopted by SLR Consulting Africa (Pty) Ltd refer to Appendix E of this report for the methodology.

The significance of the noise impacts due to project activities were found to be ***high*** (Table 14). Assuming the adoption of good practice noise mitigation and management measures as recommended, the significance of project noise impacts may be reduced to ***medium*** (Table 14).

No noise impacts are expected post-closure.

Table 14: Significance rating for noise impacts due to project activities

Project Activity	Noise		Probability	Consequence				Significance Rating
	Description	Impacts		Intensity	Duration	Extent	Consequence	
Project activities only								
Project construction activities	Impact from construction activities associated with the project	Increased noise on NSR's due to construction activities.	Without Mitigation					
			M	M	L	M	M	Low
			With Mitigation					
			M	L	L	L	L	Very Low
Project operation activities	Impact from operational activities associated with the project	Increased noise on NSR's due to operational activities.	Without Mitigation					
			H	H (a)	H	M (b)	M	High
			With Mitigation					
			H	M	H	M	M	Medium
Project closure activities	Impact from closure activities associated with the project	Increased noise on NSR's due to closure activities.	Without Mitigation					
			M	M	L	M	M	Low
			With Mitigation					
			M	L	L	L	L	Very Low
Cumulative (project activities as well as baseline noise levels)								
Project construction activities	Impact from construction activities associated with the project	Increased noise on NSR's due to construction activities.	Without Mitigation					
			M	M	L	M	M	Low
			With Mitigation					
			M	L	L	L	L	Very Low
Project operation activities	Impact from operational activities associated with the project	Increased noise on NSR's due to operational activities.	Without Mitigation					
			H	H	H	M	M	High
			With Mitigation					
			H	M	H	M	M	Medium
Project closure activities	Impact from closure activities associated with the project	Increased noise on NSR's due to closure activities.	Without Mitigation					
			M	M	L	M	M	Low
			With Mitigation					
			M	L	L	L	L	Very Low

(a) The intensity of the impact is high given the noise criteria is exceeded at NSRs and "very strong" community response is expected (refer to Section 4.2).

(b) The extent is moderate as the noise impacts will extend beyond the site boundary, affecting immediate neighbours.

6 Management Measures

In the quantification of noise emissions and simulation of noise levels as a result of the project, it was found that environmental noise evaluation criteria for residential, educational, and institutional receptors are expected to be exceeded off-site at noise sensitive receptors.

From a noise perspective, the project may proceed provided that mitigation measures be implemented to ensure minimal impacts on the surrounding environment.

6.1 Controlling Noise at the Source

6.1.1 General Good Practice Measures

For general activities, the following good engineering practice **should** be applied to **all project phases**:

- Equipment with lower sound power levels must be selected. Vendors should be required to guarantee optimised equipment design noise levels.
- Where possible, other non-routine noisy activities such as construction, decommissioning, start-up and maintenance, should be limited to day-time hours.
- A **noise complaints register must be kept**.

6.1.2 Specifications and Equipment Design

Equipment to be employed should be reviewed to ensure the quietest available technology is used. Equipment with lower sound power levels must be selected in such instances and vendors/contractors should be required to guarantee optimised equipment design noise levels.

6.1.3 Enclosures

As far as is practically possible, sources of significant noise should be enclosed. The extent of enclosure will depend on the nature of the machine and their ventilation requirements. Pumps and motors are examples of such equipment.

The compressors will also be enclosed in the refrigeration plant building. This will provide acoustic shielding to the outside through absorption of acoustic energy and transmission losses.

It should be noted that the effectiveness of partial enclosures and screens can be reduced if used incorrectly, e.g. noise should be directed into a partial enclosure and not out of it, there should not be any reflecting surfaces such as parked vehicles opposite the open end of a noise enclosure.

6.1.4 Use and Siting of Equipment and Noise Sources

The following good practice should be implemented:

a) Machines used intermittently, during construction and closure phases, should be shut down between work periods or throttled down to a minimum and not left running unnecessarily. This will reduce noise and conserve energy.
b) Equipment from which noise generated is known to be particularly directional, should be orientated so that the noise is directed away from NSRs as far as possible.
c) Acoustic covers of engines should be kept closed when in use or idling.
d) Doors to pump houses should be kept closed when in use.

6.1.5 Maintenance

Regular and effective maintenance of equipment are essential to noise control. Increases in equipment noise are often indicative of eminent mechanical failure. Also, sound reducing equipment/materials can lose effectiveness before failure and can be identified by visual inspection.

6.2 Controlling the Spread of Noise Using Barriers or Berms

If noise can be controlled at the source to meet IFC guidelines at the NSR, then no further attenuation measures will be required. However, if IFC guidelines are still exceeded at the NSR after source attenuation has been implemented, noise reduction screens, barriers, or berms must be installed.

The effectiveness of a noise barrier is dependent on its length, effective height, and position relative to the source and receiver as well as material of construction. To optimize the effect of screening, screens should be located close (**within 50 m**) to either the source of the noise, or the receiver.

The careful placement of barriers such as screens or berms can significantly reduce noise impacts but may result in additional visual impacts. Although vegetation such as shrubs or trees may improve the visual impact of construction sites, it will not significantly reduce noise impacts and should not be considered as a control measure.

Earth berms can be built to provide screening for large scale earth moving operations and can be landscaped to become permanent features once construction is completed. **Care should be taken when constructing earth berms since it may become a significant source dust.**

If exceedances of IFC guidelines are measured at the NSR, the following earth berm construction is recommended:

- Clapham Shaft Complex:
    - Height of earth berm preferably 10 m
    - Constructed not more than 50 m from the main noise sources at the Clapham Shaft Complex
- Driekop Shaft Complex:
    - Height of earth berm preferably 15 m
    - Constructed not more than 50 m from the main noise sources at the Driekop Shaft Complex

Berms can be constructed from waste rock material. It is recommended that noise sampling be undertaken at the NSRs once the berm is constructed in order to understand the effectiveness of the noise barrier. If IFC guidelines are still exceeded, the berm should be covered with topsoil and then vegetated. The vegetated berms will reduce their acoustic "hardness" and increase their attenuation potential. An unvegetated berm constructed solely from waste rock could compound impacts by reflecting noise.

The potential day- and night-time noise levels with the implementation of noise berms of 10 m at the Clapham Shaft Complex and 15 m at the Driekop Shaft Complex is provided in Figure 20 and Figure 21 respectively.

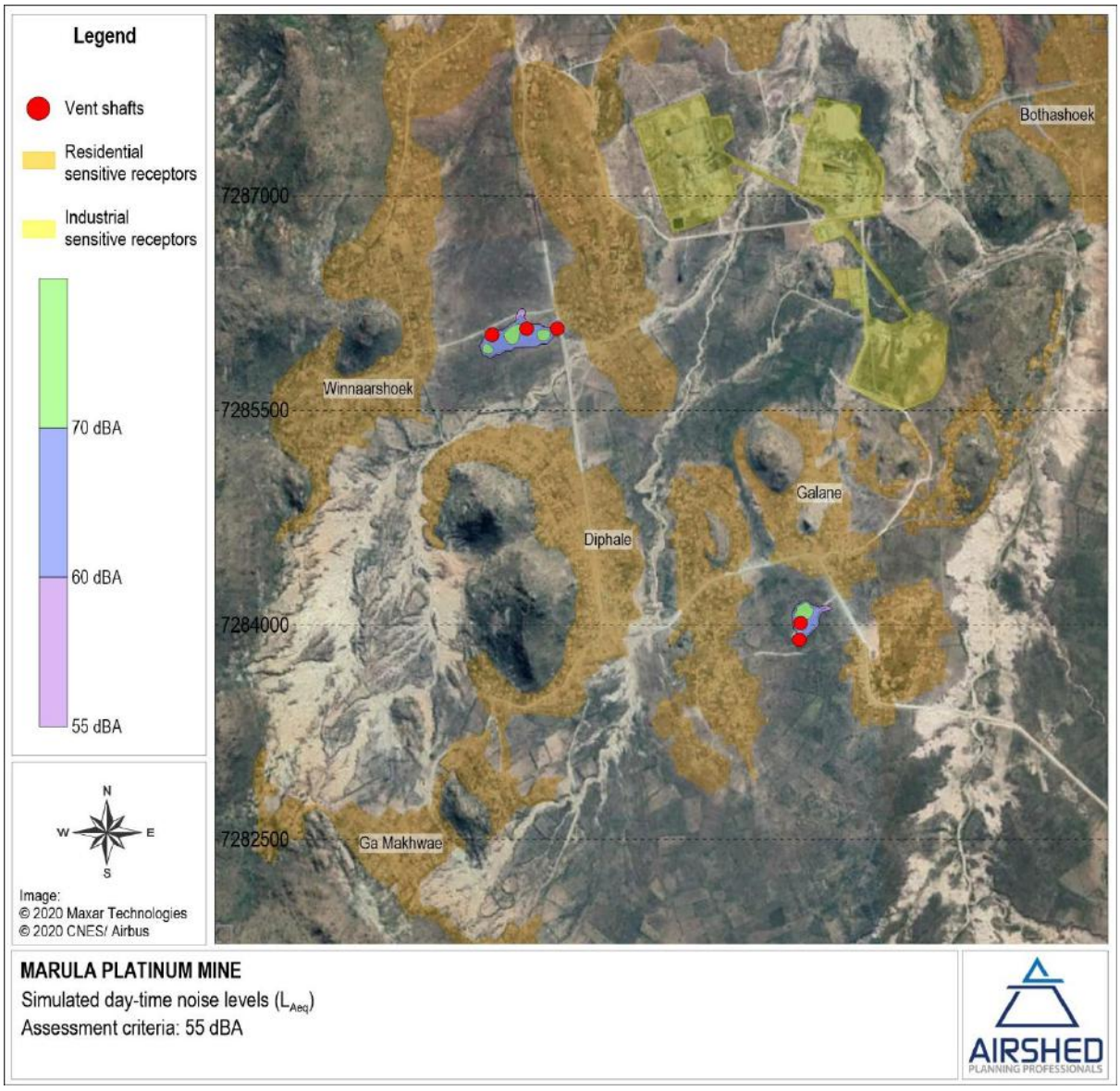


Figure 20: Simulated equivalent continuous day-time rating level ($L_{Req,d}$) for project activities assuming a 10 m berm at the Clapham Shaft Complex and a 15 m berm at the Driekop Shaft Complex

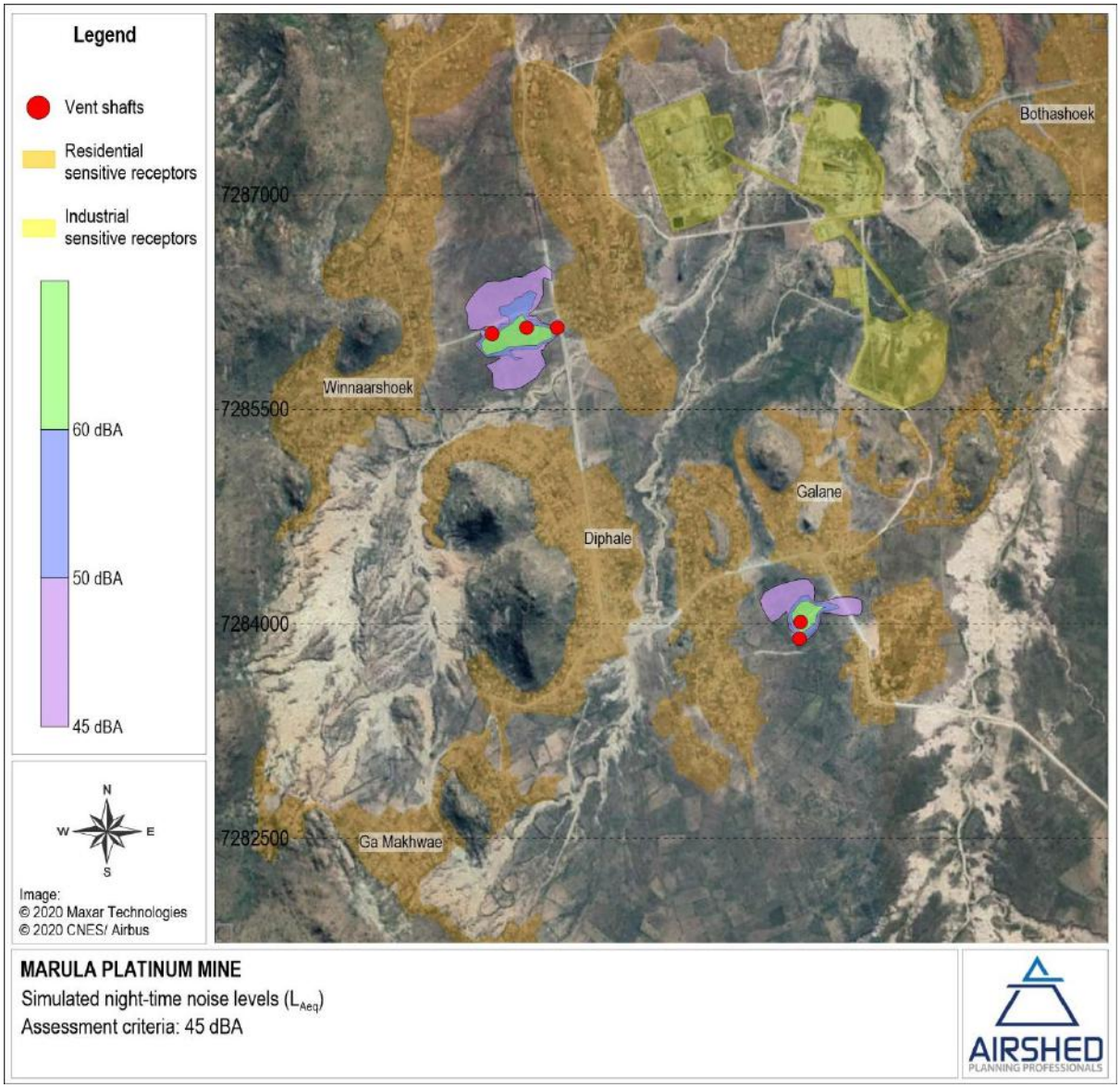


Figure 21: Simulated equivalent continuous night-time rating level ($L_{Req,n}$) for project activities assuming a 10 m berm at the Clapham Shaft Complex and a 15 m berm at the Driekop Shaft Complex

6.3 Monitoring

In the event that noise related complaints are received short term ambient noise measurements, at the complainant, should be conducted as part of investigating the complaints. The results of the measurements should be used to inform any follow up interventions. The investigation of complaints should include an investigation into equipment or machinery that likely result or resulted in noise levels annoying to the community. This could be achieved with source noise measurements.

The following procedure should be adopted for all noise surveys (for complaints):

- Any surveys should be designed and conducted by a **trained specialist**.

- Sampling should be carried out using a **Type 1** SLM that meets all appropriate IEC standards and is subject to **annual calibration** by an accredited laboratory.
- The **acoustic sensitivity of the SLM should be tested** with a portable acoustic calibrator before and after each sampling session.
- Samples sufficient for statistical analysis should be taken with the use of portable SLM's capable of logging data continuously over the time period. Samples representative of the day- and night-time acoustic environment should be taken.
- The following acoustic indices should be recoded and reported: L_{Aeq} (T), statistical noise level L_{A90}, L_{AFmin} and L_{AFmax}, octave band or 3rd octave band frequency spectra.
- The SLM should be located approximately 1.5 m above the ground and no closer than 3 m to any reflecting surface.
- Efforts should be made to ensure that measurements are not affected by the residual noise and extraneous influences, e.g. wind, electrical interference and any other non-acoustic interference, and that the instrument is operated under the conditions specified by the manufacturer. It is good practice to avoid conducting measurements when the wind speed is more than 5 m/s, while it is raining or when the ground is wet.
- A detailed log and record should be kept. Records should include site details, weather conditions during sampling and observations made regarding the acoustic environment of each site.

In addition to the above ad-hoc sampling campaigns for complaints, annual noise sampling campaigns should be conducted at Site 1, Site 2 and Site 4 (Figure 10) to understand the impacts of the project operations on the surrounding NSRs and to determine whether noise guidelines are being met. The same procedures as stipulated above should be followed.

7 Conclusion

Based on the findings of the assessment, IFC guidelines may be exceeded at NSRs within the vicinity. Provided the recommended management and mitigation measures are in place, it is the specialist opinion that the project may be authorised. A complaints register must be kept throughout the life of the operations, including during the construction of the project.

8 References

Bruce, R. D. & Moritz, C. T., 1998. Sound Power Level Predictions for Industrial Machinery. In: M. J. Crocker, ed. *Handbook of Acoustics.* Hoboken: John Whiley & Sons, Inc, pp. 863-872.

Brüel & Kjær Sound & Vibration Measurement A/S, 2000. *www.bksv.com.* [Online] Available at: http://www.bksv.com [Accessed 14 October 2011].

BSI, 2008. *Code of practice for noise and vibration control on construction and open sites - Part 1: Noise.* s.l.:s.n.

IFC, 2007. *General Environmental, Health and Safety Guidelines,* s.l.: s.n.

SANS 10103, 2008. *The measurement and rating of environmental noise with respect to annoyance and to speech communication,* Pretoria: Standards South Africa.

The Republic of South Africa, 1992. *Noise Control Regulations in terms of Section 25 of the Environment Conservation Act, Notice R154, Government Gazette 13717, 10 January 1992.* s.l.:Government Printing Works.

WHO, 1999. *Guidelines to Community Noise.* s.l.:s.n.

Appendix A – Specialist Curriculum Vitae

FULL CURRICULUM VITAE

Name of Firm	Airshed Planning Professionals (Pty) Ltd
Name of Staff	René von Gruenewaldt (*nee* Thomas)
Profession	Air Quality Scientist
Date of Birth	13 May 1978
Years with Firm	More than 15 years
Nationalities	South African

MEMBERSHIP OF PROFESSIONAL SOCIETIES

- Registered Professional Natural Scientist (Registration Number 400304/07) with the South African Council for Natural Scientific Professions (SACNASP)
- Member of the National Association for Clean Air (NACA)

KEY QUALIFICATIONS

René von Gruenewaldt (Air Quality Scientist): René joined Airshed Planning Professionals (Pty) Ltd (previously known as Environmental Management Services cc) in 2002. She has, as a Specialist, attained over fifteen (15) years of experience in the Earth and Natural Sciences sector in the field of Air Quality and seven (7) years of experience in the field of noise assessments. As an environmental practitioner, she has provided solutions to both large-scale and smaller projects within the mining, minerals, and process industries.

She has developed technical and specialist skills in various modelling packages including the AMS/EPA Regulatory Models (AERMOD and AERMET), UK Gaussian plume model (ADMS), EPA Regulatory puff based model (CALPUFF and CALMET), puff based HAWK model and line based models. Her experience with emission models includes Tanks 4.0 (for the quantification of tank emissions), WATER9 (for the quantification of waste water treatment works) and GasSim (for the quantification of landfill emissions). Noise propagation modelling proficiency includes CONCAWE, South African National Standards (SANS 10210) for calculating and predicting road traffic noise and CadnaA.

Having worked on projects throughout Africa (i.e. South Africa, Mozambique, Malawi, Kenya, Angola, Democratic Republic of Congo, Namibia, Madagascar and Egypt) René has developed a broad experience base. She has a good understanding of the laws and regulations associated with ambient air quality and emission limits in South Africa and various other African countries, as well as the World Bank Guidelines, European Community Limits and World Health Organisation.

RELEVANT EXPERIENCE

Mining and Ore Handling

René has undertaken numerous air quality impact assessments and management plans for coal, platinum, uranium, copper, cobalt, chromium, fluorspar, bauxite, manganese and mineral sands mines. These include: compilation of emissions databases for Landau and New Vaal coal collieries (SA), impact assessments and management plans for numerous mines over Mpumalanga (viz. Schoonoord, Belfast, Goedgevonden, Mbila, Evander South, Driefontein, Hartogshoop, Belfast, New Largo, Geluk, etc.), Mmamabula Coal Colliery (Botswana), Moatize Coal Colliery (Mozambique), Revuboe Coal Colliery (Mozambique), Toliera Sands Heavy Minerals Mine and Processing (Madagascar), Corridor Sands Heavy Minerals Mine monitoring assessment, El Burullus Heavy Minerals Mine and processing (Egypt), Namakwa Sands Heavy Minerals Mine (SA), Tenke Copper Mine and Processing Plant (DRC), Rössing Uranium (Namibia), Lonmin platinum mines including operations at Marikana, Baobab, Dwaalkop and Doornvlei (SA), Impala Platinum (SA), Pilannesburg Platinum (SA), Aquarius Platinum, Hoogland Platinum Mine (SA), Tamboti PGM Mine (SA), Sari Gunay Gold Mine (Iran), chrome mines in the Steelpoort Valley (SA), Mecklenburg Chrome Mine (SA), Naboom Chrome Mine (SA), Kinsenda Copper Mine (DRC), Kassinga Mine (Angola) and Nokeng Flourspar Mine (SA), etc.

Mining monitoring reviews have also been undertaken for Optimum Colliery's operations near Hendrina Power Station and Impunzi Coal Colliery with a detailed management plan undertaken for Morupule (Botswana) and Glencor (previously known as Xstrata Coal South Africa).

Air quality assessments have also been undertaken for mechanical appliances including the Durban Coal Terminal and Nacala Port (Mozambique) as well as rail transport assessments including BHP-Billiton Bauxite transport (Suriname), Nacala Rail Corridor (Mozambique and Malawi), Kusile Rail (SA) and WCL Rail (Liberia).

Metal Recovery

Air quality impact assessments have been carried out for Highveld Steel, Scaw Metals, Lonmin's Marikana Smelter operations, Saldanha Steel, Tata Steel, Afro Asia Steel and Exxaro's Manganese Pilot Plant Smelter (Pretoria).

Chemical Industry

Comprehensive air quality impact assessments have been completed for NCP (including Chloorkop Expansion Project, Contaminated soils recovery, C3 Project and the 200T Receiver Project), Revertex Chemicals (Durban), Stoppani Chromium Chemicals, Foskor (Richards Bay), Straits Chemicals (Coega), Tenke Acid Plant (DRC), and Omnia (Sasolburg).

Petrochemical Industry

Numerous air quality impact assessments have been completed for Sasol (including the postponement/exemption application for Synfuels, Infrachem, Natref, MIBK2 Project, Wax Project, GTL Project, re-commissioning of boilers at Sasol Sasolburg and Ekandustria), Engen Emission Inventory Functional Specification (Durban), Sapref refinery (Durban), Sasol (at Elrode) and Island View (in Durban) tanks quantification, Petro SA and Chevron (including the postponement/exemption application).

Pulp and Paper Industry

Air quality studies have been undertaken or the expansion of Mondi Richards Bay, Multi-Boiler Project for Mondi Merebank (Durban), impact assessments for Sappi Stanger, Sappi Enstra (Springs), Sappi Ngodwana (Nelspruit) and Pulp United (Richards Bay).

Power Generation

Air quality impact assessments have been completed for numerous Eskom coal fired power station studies including the ash expansion projects at Kusile, Kendal, Hendrina, Kriel and Arnot; Fabric Filter Plants at Komati, Grootvlei, Tutuka, Lethabo and Kriel Power Stations; the proposed Kusile, Medupi (including the impact assessment for the Flue Gas Desulphurization) and Vaal South Power Stations. René was also involved and the cumulative assessment of the existing and return to service Eskom power stations assessment and the optimization of Eskom's ambient air quality monitoring network over the Highveld.

In addition to Eskom's coal fired power stations, various Eskom nuclear power supply projects have been completed including the air quality assessment of Pebble Bed Modular Reactor and nuclear plants at Duynefontein, Bantamsklip and Thyspunt.

Apart from Eskom projects, power station assessments have also been completed in Kenya (Rabai Power Station) and Namibia (Paratus Power Plant).

Waste Disposal

Air quality impact assessments, including odour and carcinogenic and non-carcinogenic pollutants were undertaken for the Waste Water Treatment Works in Magaliesburg, proposed Waterval Landfill (near Rustenburg), Tutuka Landfill, Mogale General Waste Landfill (adjacent to the Leipardsvlei Landfill), Cape Winelands District Municipality Landfill and the Tsoeneng Landfill (Lesotho). Air quality impact assessments have also been completed for the BCL incinerator (Cape Town), the Ergo Rubber Incinerator and the Ecorevert Pyrolysis Plant.

Cement Manufacturing

Impact assessments for ambient air quality have been completed for the Holcim Alternative Fuels Project (which included the assessment of the cement manufacturing plants at Ulco and Dudfield as well as a proposed blending platform in Roodepoort).

Management Plans

René undertook the quantification of the baseline air quality for the first declared Vaal Triangle Airshed Priority Area. This included the establishment of a comprehensive air pollution emissions inventory, atmospheric dispersion modelling, focusing on impact area "hotspots" and quantifying emission reduction strategies. The management plan was published in 2009 (Government Gazette 32263).

René has also been involved in the Provincial Air Quality Management Plan for the Limpopo Province.

Other Experience (2001)

Research for B.Sc Honours degree was part of the "Highveld Boundary Layer Wind" research group and was based on the identification of faulty data from the Majuba Sodar. The project was THRIP funded and was a joint venture with the University of Pretoria, Eskom and Sasol (2001).

EDUCATION

M.Sc Earth Sciences	University of Pretoria, RSA, Cum Laude (2009) Title: *An Air Quality Baseline Assessment for the Vaal Airshed in South Africa*
B.Sc Hons. Earth Sciences	University of Pretoria, RSA, Cum Laude (2001) Environmental Management and Impact Assessments
B.Sc Earth Sciences	University of Pretoria, RSA, (2000) Atmospheric Sciences: Meteorology

ADDITIONAL COURSES

CALMET/CALPUFF	Presented by the University of Johannesburg, RSA (March 2008)
Air Quality Management	Presented by the University of Johannesburg, RSA (March 2006)
ARCINFO	GIMS, Course: Introduction to ARCINFO 7 (2001)

COUNTRIES OF WORK EXPERIENCE

South Africa, Mozambique, Malawi, Liberia, Kenya, Angola, Democratic Republic of Congo, Lesotho, Namibia, Madagascar, Egypt, Suriname and Iran.

EMPLOYMENT RECORD

January 2002 - Present

Airshed Planning Professionals (Pty) Ltd, (previously known as Environmental Management Services cc until March 2003), Principal Air Quality Scientist, Midrand, South Africa.

2001

University of Pretoria, Demi for the Geography and Geoinformatics department and a research assistant for the Atmospheric Science department, Pretoria, South Africa.

Department of Environmental Affairs and Tourism, assisted in the editing of the Agenda 21 document for the world summit (July 2001), Pretoria, South Africa.

1999 - 2000

The South African Weather Services, vacation work in the research department, Pretoria, South Africa.

CONFERENCE AND WORKSHOP PRESENTATIONS AND PAPERS

- Understanding the Synoptic Systems that lead to Strong Easterly Wind Conditions and High Particulate Matter Concentrations on The West Coast of Namibia, H Liebenberg-Enslin, R von Gruenewaldt, H Rauntenbach and L Burger. National Association for Clean Air (NACA) conference, October 2017.
- Topographical Effects on Predicted Ground Level Concentrations using AERMOD, R.G. von Gruenewaldt. National Association for Clean Air (NACA) conference, October 2011.
- Emission Factor Performance Assessment for Blasting Operations, R.G. von Gruenewaldt. National Association for Clean Air (NACA) conference, October 2009.
- Vaal Triangle Priority Area Air Quality Management Plan – Baseline Characterisation, R.G. Thomas, H Liebenberg-Enslin, N Walton and M van Nierop. National Association for Clean Air (NACA) conference, October 2007.
- A High-Resolution Diagnostic Wind Field Model for Mesoscale Air Pollution Forecasting, R.G. Thomas, L.W. Burger, and H Rautenbach. National Association for Clean Air (NACA) conference, September 2005.
- Emissions Based Management Tool for Mining Operations, R.G. Thomas and L.W. Burger. National Association for Clean Air (NACA) conference, October 2004.
- An Investigation into the Accuracy of the Majuba Sodar Mixing Layer Heights, R.G. Thomas. Highveld Boundary Layer Wind Conference, November 2002.

LANGUAGES

	Speak	Read	Write
English	Excellent	Excellent	Excellent
Afrikaans	Fair	Good	Good

CERTIFICATION

I, the undersigned, certify that to the best of my knowledge and belief, these data correctly describe me, my qualifications, and my experience.

Signature of staff member

10/06/2020

Date (Day / Month / Year)

Full name of staff member: René Georgeinna von Gruenewaldt

Appendix B – Declaration of Independence

DECLARATION OF INDEPENDENCE - PRACTITIONER

Name of Practitioner: René von Gruenewaldt
Name of Registration Body: South African Council for Natural Scientific Professions
Professional Registration No.: 400304/07

Declaration of independence and accuracy of information provided:
Atmospheric Impact Report in terms of section 30 of the Act.
I, René von Gruenewaldt, declare that I am independent of the applicant. I have the necessary expertise to conduct the assessments required for the report and will perform the work relating the application in an objective manner, even if this results in views and findings that are not favourable to the applicant. I will disclose to the applicant and the air quality officer 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 air quality officer. The additional information provided in this atmospheric impact report is, to the best of my knowledge, in all respects factually true and correct. I am aware that the supply of false or misleading information to an air quality officer is a criminal offence in terms of section 51(1)(g) of this Act.

Signed at Midrand on this 3rd of September 2020

SIGNATURE
Principal Noise Scientist
CAPACITY OF SIGNATORY

Appendix C – Sound Level Meter Calibration Certificates

nmisa
National Metrology Institute of South Africa

Certificate of Conformance

Private Bag X34, Lynnwood Ridge, Pretoria, 0040
CSIR Campus, Meiring Naude Road, Brummeria, 0184
Calibration office: +27 12 841 4623
Reception: +27 12 841 4152
Fax: +27 12 841 4458
E-mail enquiries: info@nmisa.org

Calibration of:	SOUND LEVEL METER, OCTAVE BAND FILTER, THIRD OCTAVE BAND FILTER & MICROPHONE
Manufacturer:	BRÜEL & KJÆR
Model number:	2250-L, 4950
Serial number:	2731851, 3177677
Calibrated for:	AIRSHED PLANNING PROFESSIONALS (PTY) LTD 480 Smuts Drive Halfway Gardens Midrand 1682
Calibration procedure:	AV\AS-0007 AV\AS-0010
Period of calibration:	23 – 24 October 2019

1 PROCEDURE

The sound level meter was electrically calibrated according to the relevant clauses of SANS 656 and 658 specifications. The microphone with the sound level meter was acoustically calibrated according to the relevant clauses of SANS 656 specifications. The instrument complete with filters was electrically calibrated according to IEC 61260 specification.

The results of the measurements are traceable to the national measurement standards.

The following equipment was used:

Brüel & Kjær 4226 Multi-function calibrator	(AS-52)
Inline Capacitor	(AS-98)
Madgetech PRHTemp 2000	(AS-106)
Brüel & Kjær 3630 Calibration platform	(AS-109)

Calibrated by **H Potgieter** **Metrologist (Technical Signatory)**	Checked by **R Nel** **Metrologist**	For Chief Executive Officer
Date of Issue **25 October 2019**	**Page 1 of 3**	Certificate number **AV\AS-4915**

Your measure of excellence

2 RESULTS

2.1 The following parameters of the sound level meter were calibrated and conformed to the SANS 656 and SANS 658 specifications, type 1:

Indication under reference conditions (SANS 656 clause 11.2)		U = 0,20 dB
Electrical self generated noise		
A-weighted	(14,2 dB)	U = 0,30 dB
C-weighted	(13,6 dB)	U = 0,30 dB
Linear	(19,2 dB)	U = 0,30 dB
Linearity range (primary indicator range) (SANS clause 9.9, table 11)		
1 kHz		U = 0,23 dB
4 kHz		U = 0,23 dB
8 kHz		U = 0,23 dB
Frequency Weightings (SANS 656 clauses 8.1, 11.2, tables 4 & 5)		
A-weighting	(25 Hz – 16 kHz)	U = 0,12 dB
C-weighting	(25 Hz – 16 kHz)	U = 0,12 dB
Linear	(25 Hz – 16 kHz)	U = 0,12 dB
Time weightings (SANS 656 clauses 9.2, 9.3, 9.5, 11.4, table 9, 7 & 10)		
Slow and Fast		U = 0,11 dB
Impulse		U = 0,11 dB
Peak		U = 0,09 dB
Time averaging, L_{Aeq} (SANS 658 clause 11.3.3, table 4)		U = 0,12 dB
Impulse weighted time averaging, L_{AIeq} (SANS 658 Annex C, table C1)		U = 0,12 dB
Overload indication (SANS 656 clause 11.3)		U = 0,31 dB

2.2 The following parameter of the microphone with the sound level meter were calibrated and conformed to the SANS 656 specifications, type 1:

Frequency response (SANS 656 clauses 8.1, tables 4 & 5)	
31,5 Hz – 12,5 kHz	U = 0,20 dB @ 1 kHz

Calibrated by **H Potgieter** **Metrologist (Technical Signatory)**	Checked by **R Nel** **Metrologist**	For Chief Executive Officer
Date of Issue **25 October 2019**	**Page 2 of 3**	Certificate number **AVIAS-4915**

2.3 The following parameter of the octave band filter was calibrated and conformed to the IEC 61260 specification, class 0 base 2:

Relative attenuation — $U = 0{,}10$ dB @ f_m
(IEC 61260 clause 4.4, 5.3)
16 Hz - 8 kHz

2.4 The following parameter of the third octave band filter was calibrated and conformed to the IEC 61260 specification, class 0 base 2:

Relative attenuation — $U = 0{,}10$ dB @ f_m
(IEC 61260 clause 4.4, 5.3)
12,5 Hz - 16 kHz

3 REMARKS

3.1 The reported uncertainties of measurement were calculated and expressed in accordance with the BIPM, IEC, ISO, IUPAP, OIML document entitled "A Guide to the Expression of Uncertainty in Measurement" (International Organisation for Standardisation, Geneva, Switzerland, 1993).

3.2 The reported expanded uncertainty of measurement, *U*, is stated as the standard uncertainty of measurement multiplied by a coverage factor of $k = 2$, which for a normal distribution approximates a level of confidence of 95,45 %. The reported expanded uncertainty of measurements is at the reference points.

3.3 Certain of the NMISA certificates are consistent with the capabilities that are included in appendix C of the MRA (Mutual Recognition Arrangement) drawn up by the CIPM. Under the MRA, all participating institutes recognise the validity of each other's calibration and measurement certificates for the quantities and ranges and measurement uncertainties specified in Appendix C. For details see http://www.bipm.org.

3.4 The calibrations were carried out at an ambient temperature of 23 °C ± 2 °C and a relative humidity of 50 %RH ± 20 %RH.

3.5 Only parameters given in 2.1, 2.2, 2.3 and 2.4 were calibrated.

3.6 The above statement of conformance is based on the measurement value(s) obtained, extended by the estimated uncertainty of measurement, being within the appropriate specification limit(s).

3.7 The firmware versions of the sound measuring device at the time of calibration were: BZ7130 V4.7.4; BZ7131 V4.7.4; BZ7132 V4.7.4.

---------- *end of certificate* ----------

Calibrated by	Checked by	For Chief Executive Officer
H Potgieter **Metrologist (Technical Signatory)**	**R Nel** **Metrologist**	
Date of Issue **25 October 2019**	**Page 3 of 3**	Certificate number **AVIAS-4915**

nmisa
National Metrology Institute of South Africa

Certificate of Conformance

Private Bag X34, Lynnwood Ridge, Pretoria, 0040
CSIR Campus, Meiring Naude Road, Brummeria, 0184
Calibration office: +27 12 841 4623
Reception: +27 12 841 4152
Fax: +27 12 841 4458
E-mail enquiries: info@nmisa.org

Calibration of:	SOUND CALIBRATOR
Manufacturer:	SVANTEK
Model number:	SV 33
Serial number:	43170
Calibrated for:	AIRSHED PLANNING PROFESSIONALS (PTY) LTD 480 Smuts Drive Halfway Gardens Midrand 1682
Calibration procedure:	AV\AS-0008
Period of calibration:	25 October 2019

1 PROCEDURE

The sound calibrator was calibrated according to IEC 60942: 2003 specification.

The results of the measurements are traceable to the national measurement standards.

The following equipment was used:

Brüel & Kjær 2673 preamplifier	(AS-146)
MadgeTech PRHTemp2000	(AS-106)
Brüel & Kjær 3630 Calibration platform	(AS-109)
Brüel & Kjær 4228 Pistonphone	(AS-WSTD-10)
Brüel & Kjær 4192 Pressure Microphone	(AS-WSTD-15)

Calibrated by **R Nel** **Metrologist (Technical Signatory)**	Checked by **H Potgieter** **Metrologist**	For Chief Executive Officer
Date of Issue **25 October 2019**	**Page 1 of 2**	Certificate number **AV\AS-4916**

Your measure of excellence

2 RESULTS

2.1 The following parameters of the sound calibrator were calibrated and conformed to IEC 60942: 2003 specification, class 1:

Frequency (IEC 60942 clause B.3.5) 1 000 Hz	U = 0,10 Hz
Sound Pressure Level (IEC 60942 clause B.3.4) 114 dB	U = 0,15 dB
Total Distortion (IEC 60942 clause B.3.6)	U = 0,30 %

3 REMARKS

3.1 The reported uncertainties of measurement were calculated and expressed in accordance with the BIPM, IEC, ISO, IUPAP, OIML document entitled "A Guide to the Expression of Uncertainty in Measurement" (International Organisation for Standardisation, Geneva, Switzerland, 1993).

3.2 The reported expanded uncertainty of measurement, U, is stated as the standard uncertainty of measurement multiplied by a coverage factor of $k = 2$, which for a normal distribution approximates a level of confidence of 95,45 %.

3.3 Certain of the NMISA certificates are consistent with the capabilities that are included in appendix C of the MRA (Mutual Recognition Arrangement) drawn up by the CIPM. Under the MRA, all participating institutes recognise the validity of each other's calibration and measurement certificates for the quantities and ranges and measurement uncertainties specified in Appendix C. For details see http://www.bipm.org.

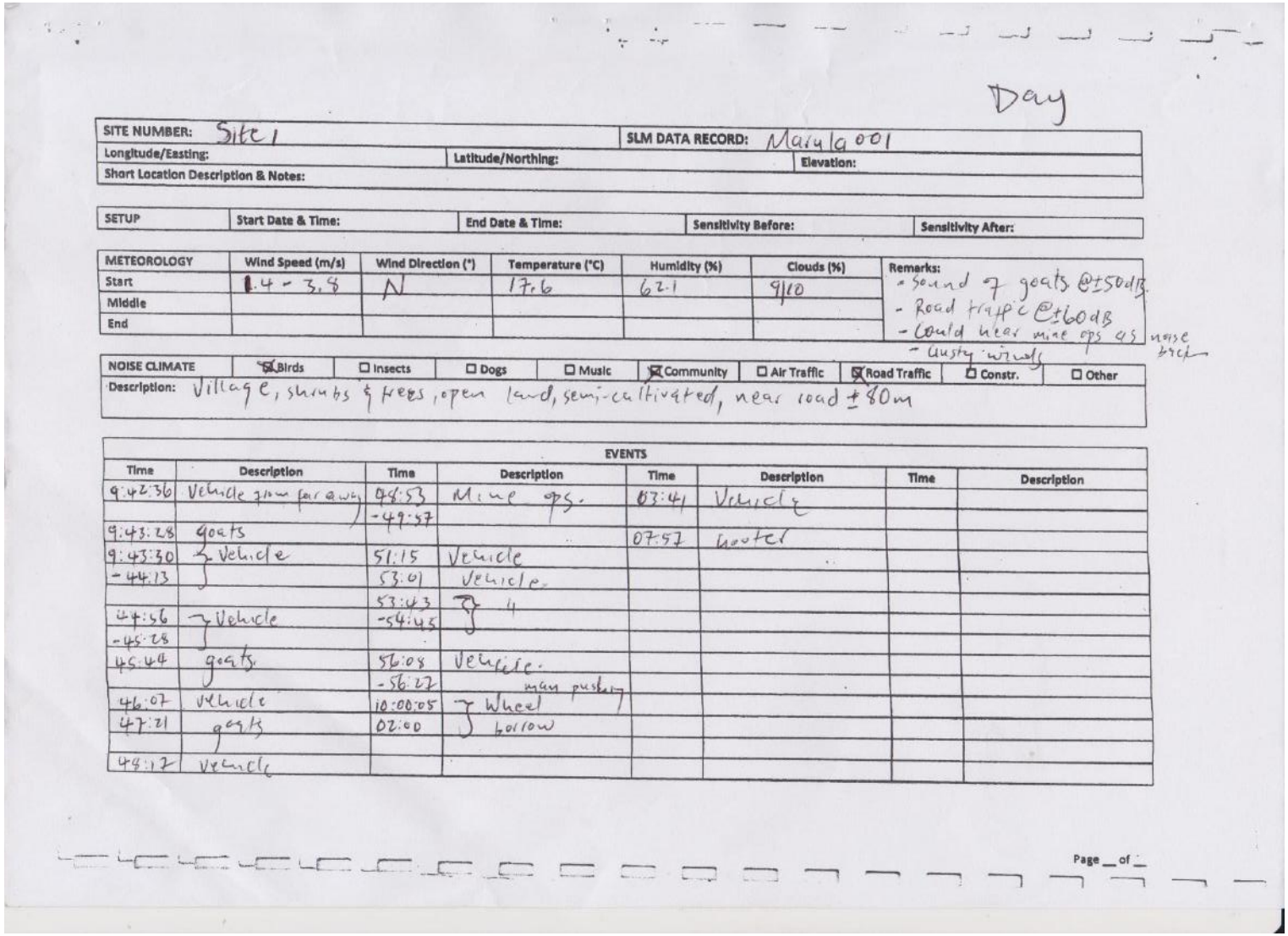
3.4 The calibrations were carried out at an ambient temperature of 23 °C ± 2 °C and a relative humidity of 50 %RH ± 20 %RH.

3.5 The above statement of conformance is based on the measurement value(s) obtained, extended by the estimated uncertainty of measurement, being within the appropriate specification limit(s).

---------- *end of certificate* ----------

Calibrated by	Checked by	For Chief Executive Officer
R Nel **Metrologist (Technical Signatory)**	**H Potgieter** **Metrologist**	
Date of issue **25 October 2019**	**Page 2 of 2**	Certificate number **AV\AS-4916**

Appendix D – Fieldwork Log Sheets and Photos



Day

SITE NUMBER: Site 1				SLM DATA RECORD: Marula 001	
Longitude/Easting:		Latitude/Northing:		Elevation:	
Short Location Description & Notes:					

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.4 - 3.8	N	17.6	62.1	9/10	- Sound of goats @ ±50dB - Road traffic @ ±60dB - Could hear mine ops as noise brck - Dusty winds
Middle						
End						

NOISE CLIMATE	☒ Birds	☐ Insects	☐ Dogs	☐ Music	☒ Community	☐ Air Traffic	☒ Road Traffic	☐ Constr.	☐ Other
Description: Village, shrubs & trees, open land, semi-cultivated, near road ± 80m									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
9:42:36	Vehicle from far away	48:53	Mine ops.	03:41	Vehicle		
		-49:57					
9:43:28	goats			07:57	hooter		
9:43:30	} Vehicle	51:15	Vehicle				
-44:13	}	53:01	Vehicle.				
		53:43	} 4				
44:56	} Vehicle	-54:45	}				
-45:28	}						
45:44	goats	56:08	Vehicle.				
		-56:27	man pushing				
46:07	Vehicle	10:00:05	} Wheel				
47:21	goats	02:00	} barrow				
48:17	Vehicle						

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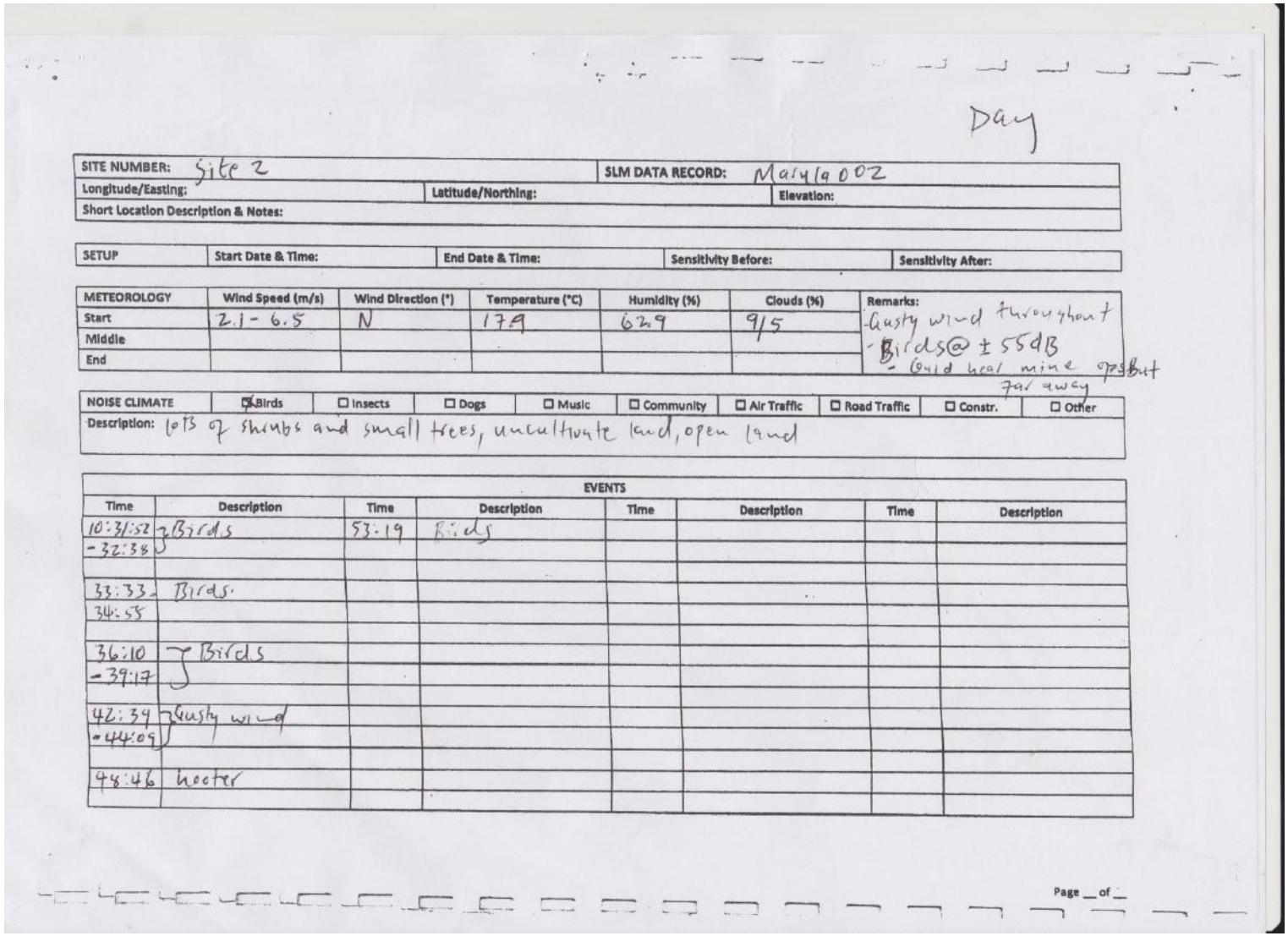

Day

SITE NUMBER:	Site 2		SLM DATA RECORD:	Marula 002
Longitude/Easting:		Latitude/Northing:		Elevation:
Short Location Description & Notes:				

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	2.1 - 6.5	N	17.9	62.9	9/5	-Gusty wind throughout -Birds @ ± 55dB - Could hear mine ops but far away
Middle						
End						

NOISE CLIMATE	☒ Birds	☐ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other

Description: lots of shrubs and small trees, uncultivate land, open land

EVENTS							
Time	Description	Time	Description	Time	Description	Time	Description
10:31:52 - 32:38	Birds	53:19	Birds				
33:33 - 34:55	Birds						
36:10 - 39:17	Birds						
42:39 - 44:09	Gusty wind						
48:46	heater						

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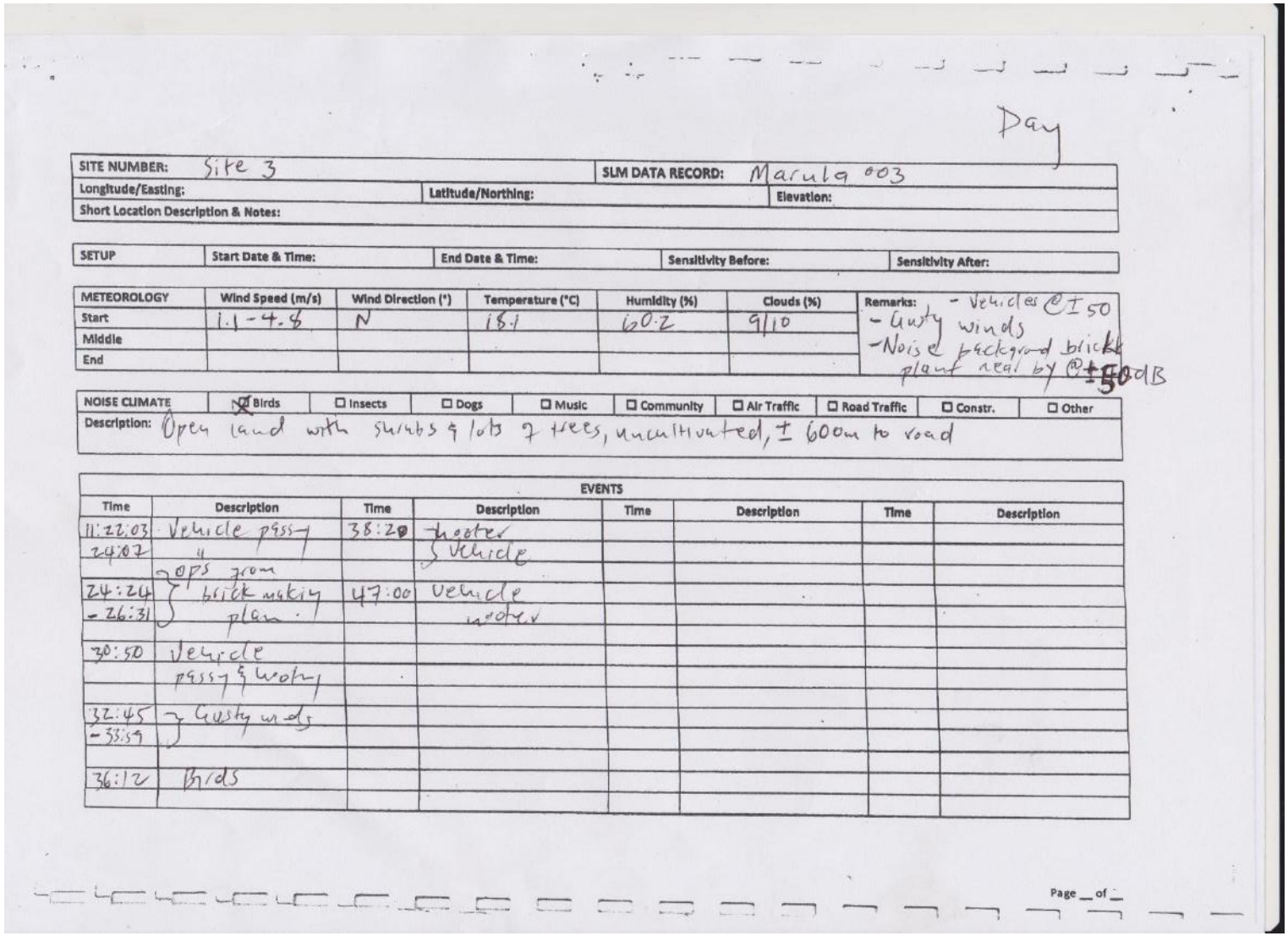


Day

SITE NUMBER:	Site 3			SLM DATA RECORD:	Marula 003
Longitude/Easting:		Latitude/Northing:		Elevation:	
Short Location Description & Notes:					

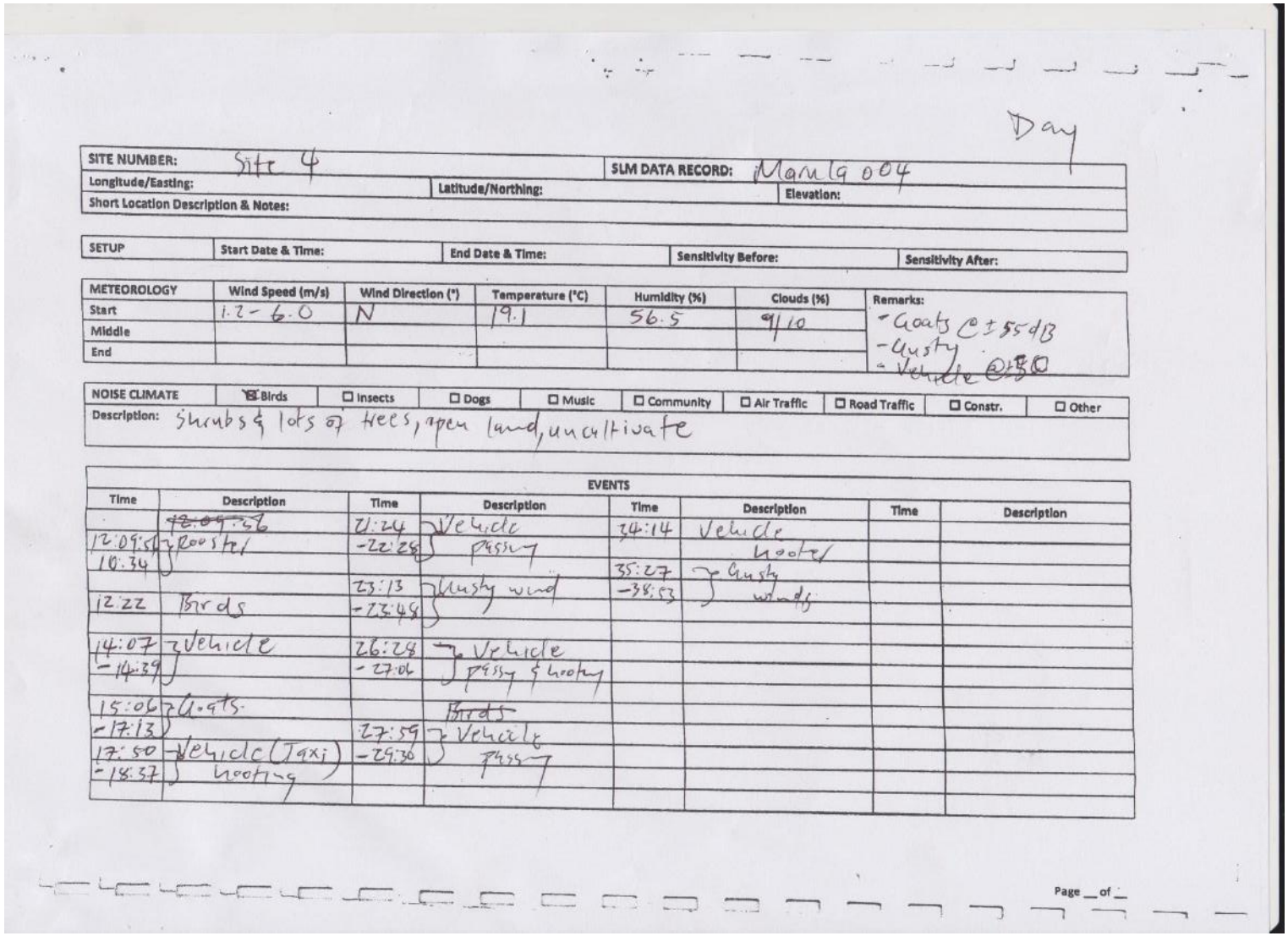
SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.1-4.8	N	18.1	60.2	9/10	- Vehicles @ I 50 - Gusty winds - Noise of background brick plant near by @ ± 50dB
Middle						
End						

NOISE CLIMATE	☒ Birds	☐ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:	Open land with shrubs & lots of trees, uncultivated, ± 600m to road								

EVENTS							
Time	Description	Time	Description	Time	Description	Time	Description
11:22:03	Vehicle passy	38:20	Hooter & Vehicle				
24:07	4 ops from brick making plan.	47:00	Vehicle hooter				
24:24 - 26:31							
30:50	Vehicle passy & hooting						
32:45 - 33:59	Gusty winds						
36:12	Birds						

Page __ of __



Day

SITE NUMBER:	Site 4			SLM DATA RECORD:	Marula 004
Longitude/Easting:		Latitude/Northing:		Elevation:	
Short Location Description & Notes:					

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.2 - 6.0	N	19.1	56.5	9/10	- Goats @ ± 55 dB - Gusty - Vehicle @ 50
Middle						
End						

NOISE CLIMATE	☒ Birds	☐ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other

Description: Shrubs & lots of trees, open land, uncultivate

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
~~12:09:56~~		21:24	Vehicle	34:14	Vehicle		
12:09:56 - 10:34	Rooster	-22:28	passing		hooter		
				35:27 - 38:53	Gusty winds		
		23:13 - 23:48	Gusty wind				
12:22	Birds						
14:07 - 14:39	Vehicle	26:28 - 27:04	Vehicle passing & hooting				
15:06 - 17:13	Goats		Birds				
		27:59 - 29:30	Vehicle passing				
17:50 - 18:37	Vehicle (Taxi) hooting						

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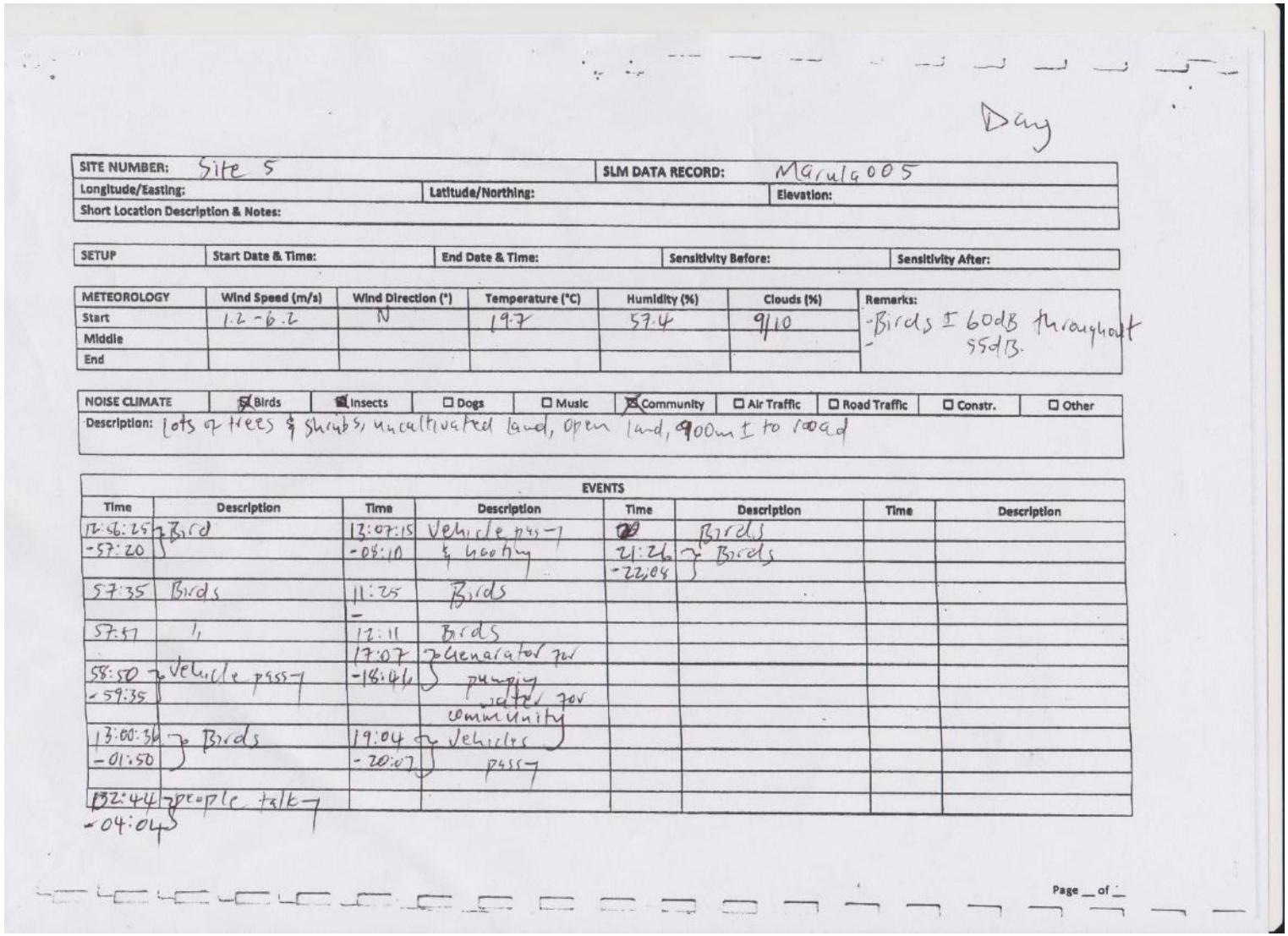


Day

SITE NUMBER:	Site 5			SLM DATA RECORD:	Marula005
Longitude/Easting:		Latitude/Northing:		Elevation:	
Short Location Description & Notes:					

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

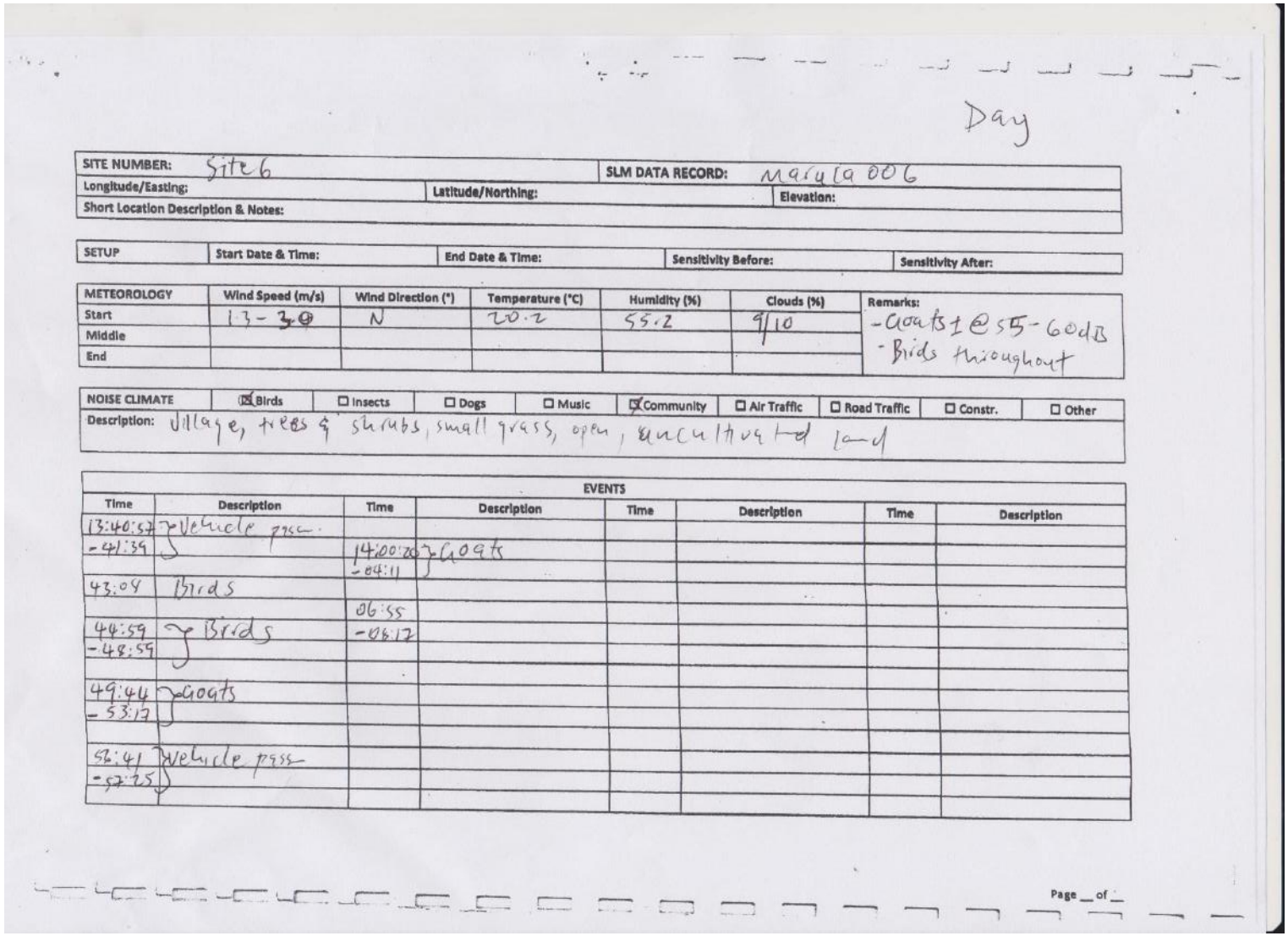
METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.2 - 6.2	N	19.7	57.4	9/10	- Birds I 60dB throughout 55dB.
Middle						
End						

NOISE CLIMATE	☒ Birds	☒ Insects	☐ Dogs	☐ Music	☒ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other

Description: Lots of trees & shrubs, uncultivated land, open land, 900m I to road

EVENTS							
Time	Description	Time	Description	Time	Description	Time	Description
12:56:25 - 57:20	Bird	13:07:15 - 08:10	Vehicle pass-by & hooting	20 21:26 - 22:04	Birds - Birds		
57:35	Birds	11:25 - 12:11	Birds				
57:57	〃	17:07 - 18:46	Generator for pumping water for community				
58:50 - 59:35	Vehicle pass-by						
13:00:34 - 01:50	Birds	19:04 - 20:07	Vehicles pass-by				
02:44 - 04:04	people talk						

Page __ of __



Day

SITE NUMBER:	Site 6			SLM DATA RECORD:	Marula 006
Longitude/Easting:		Latitude/Northing:		Elevation:	
Short Location Description & Notes:					

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.3 - 3.9	N	20.2	55.2	9/10	- Goats 1 @ 55 - 60dB - Birds throughout
Middle						
End						

NOISE CLIMATE	☒ Birds	☐ Insects	☐ Dogs	☐ Music	☒ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other

Description: Village, trees & shrubs, small grass, open, uncultivated land

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
13:40:57 - 41:39	Vehicle pass						
		14:00:20 - 04:11	Goats				
43:04	Birds						
		06:55 - 06:12					
44:59 - 48:59	Birds						
49:44 - 53:17	Goats						
56:41 - 57:25	Vehicle pass						

Page __ of __

Event 1 17/08/2020

SITE NUMBER:	Site 1	SLM DATA RECORD:	marula_ev_001
Longitude/Easting:	Latitude/Northing:	Elevation:	
Short Location Description & Notes:			

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

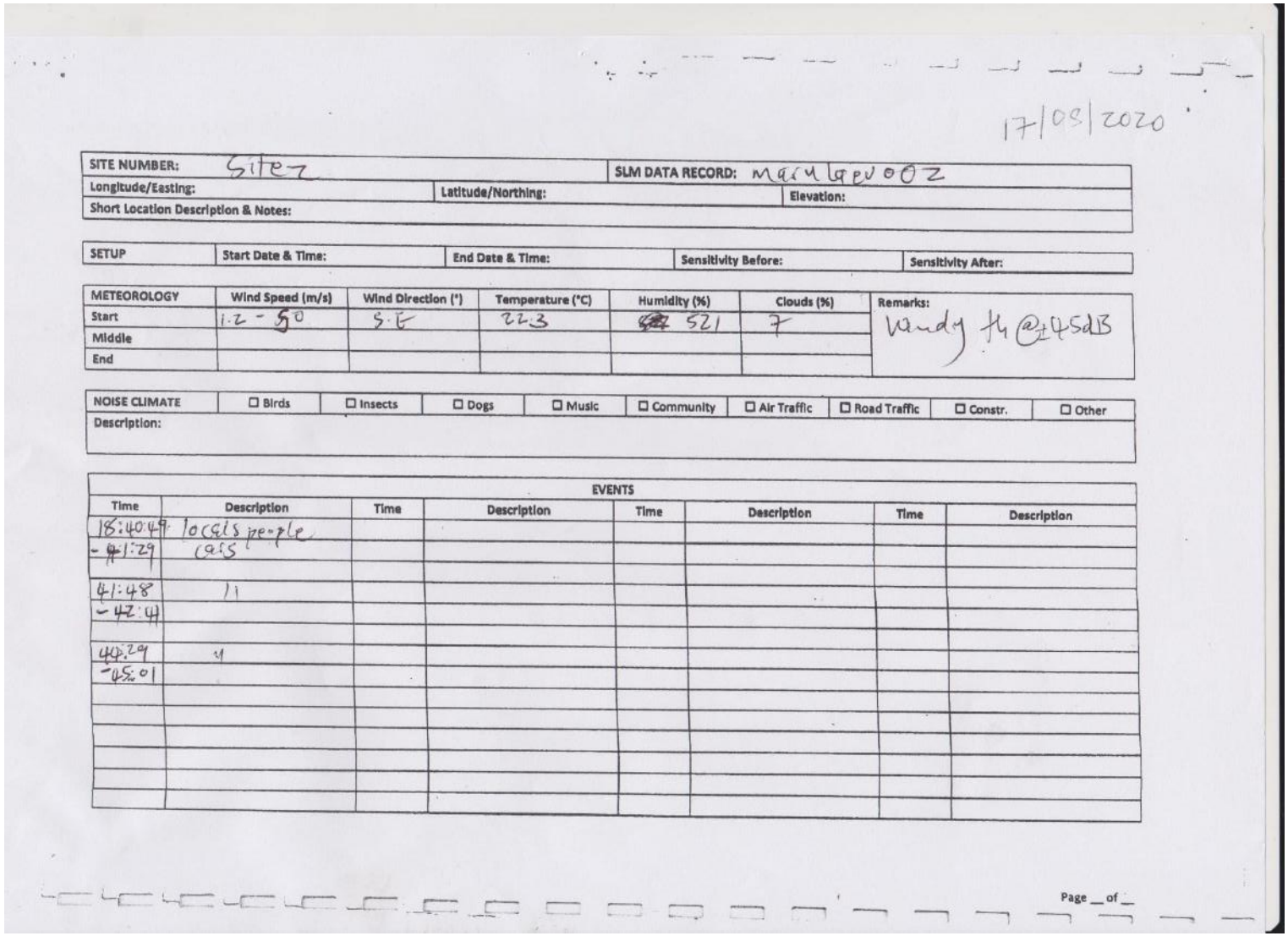
METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.1 - 4.1	S-E	22.4	54.1	7	-Windy
Middle						
End						

NOISE CLIMATE	☒ Birds	☒ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☒ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
18:22:54	Hooter/vehicle						
24:25 - 24:12	3 vehicle pass						
25:22 - 26:08	2 "						
29:41	Vehicle pass						
30:59	"						

Page __ of __



17/05/2020

SITE NUMBER: Site 7		SLM DATA RECORD: Marula_rev002
Longitude/Easting:	Latitude/Northing:	Elevation:
Short Location Description & Notes:		

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

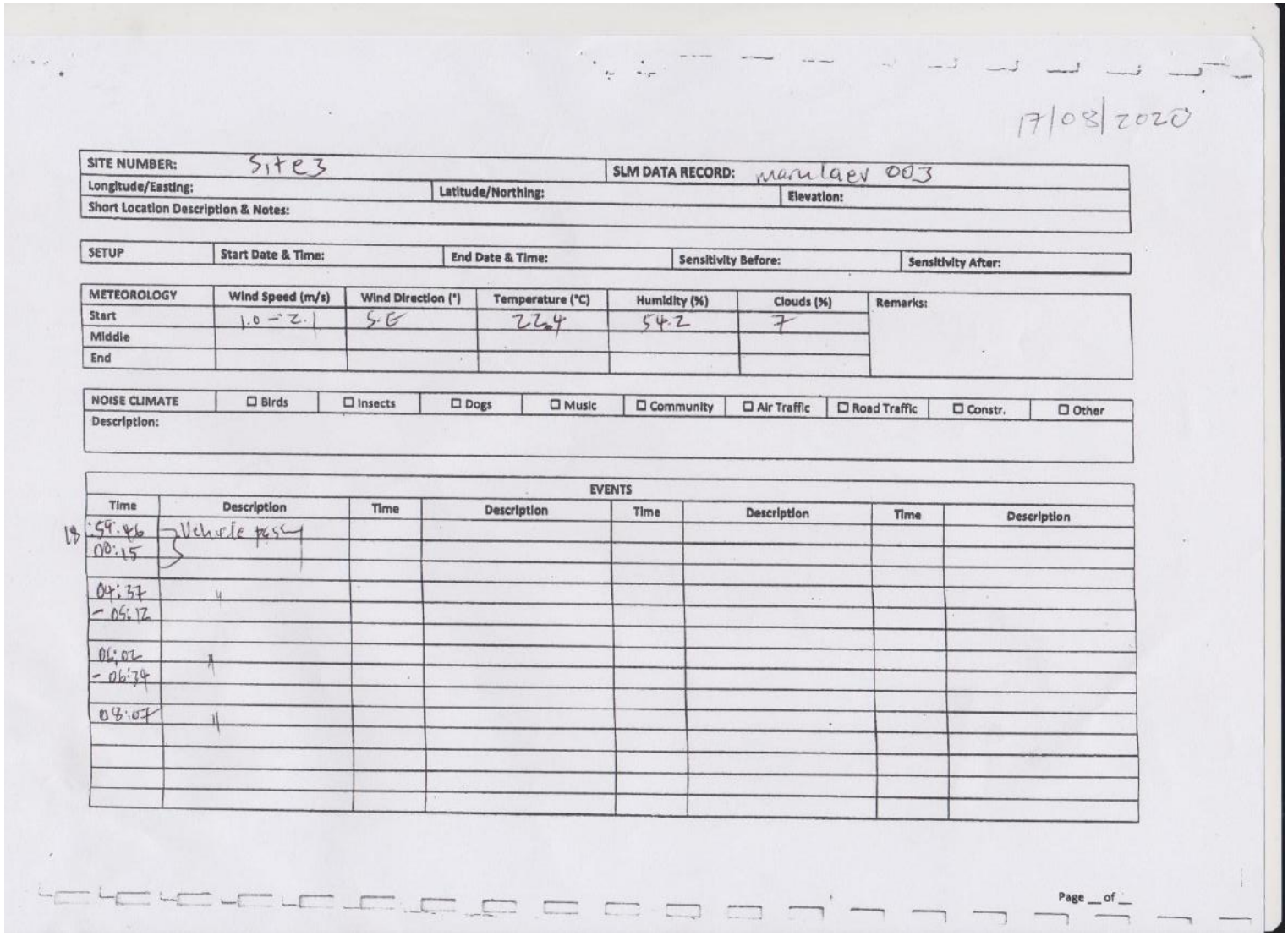
METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.2 - 5.0	S-E	22.3	52.1	7	Windy 4 @ 14:58
Middle						
End						

NOISE CLIMATE	☐ Birds	☐ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
18:40:49	locals people cars						
- 41:29							
41:48	11						
- 42:4							
44:29	4						
- 45:01							

Page __ of __



17/08/2020

SITE NUMBER:	Site3			SLM DATA RECORD:	marulaev 003
Longitude/Easting:		Latitude/Northing:		Elevation:	
Short Location Description & Notes:					

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

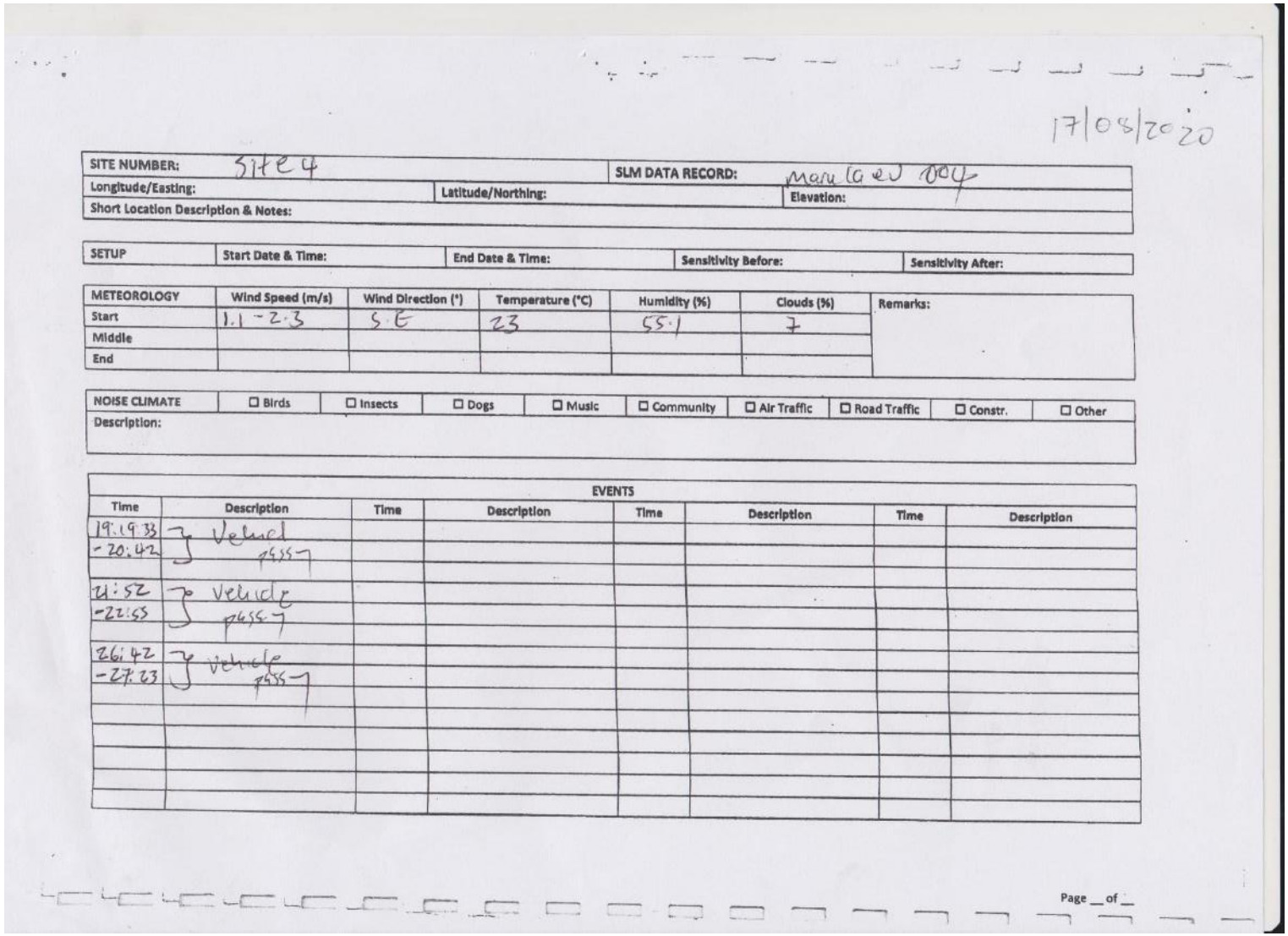
METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.0 - 2.1	S.E	22.4	54.2	7	
Middle						
End						

NOISE CLIMATE	☐ Birds	☐ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
18 :59:46	Vehicle pass						
00:15							
04:37	4						
- 05:12							
06:02	1						
- 06:34							
08:07	1						

Page __ of __



17/08/2020

SITE NUMBER:	Site 4			SLM DATA RECORD:	Marula EJ 004
Longitude/Easting:		Latitude/Northing:		Elevation:	
Short Location Description & Notes:					

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

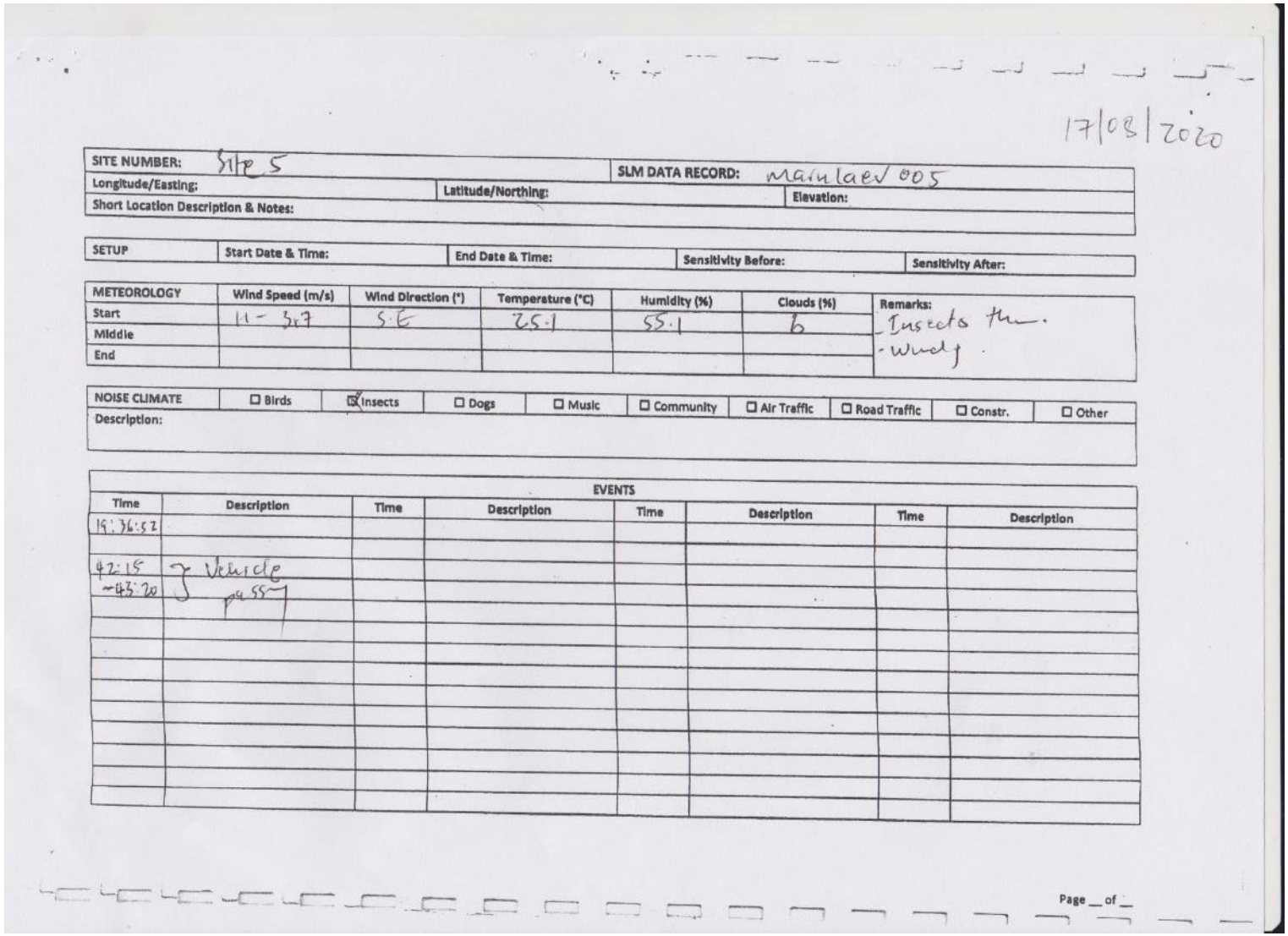
METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.1 - 2.3	S E	23	55.1	7	
Middle						
End						

NOISE CLIMATE	☐ Birds	☐ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
19:19:33 - 20:42	Vehicle pass						
21:52 - 22:55	Vehicle pass						
26:42 - 27:23	Vehicle pass						

Page __ of __



17/08/2020

SITE NUMBER:	Site 5			SLM DATA RECORD:	Marulaev 005
Longitude/Easting:		Latitude/Northing:		Elevation:	
Short Location Description & Notes:					

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

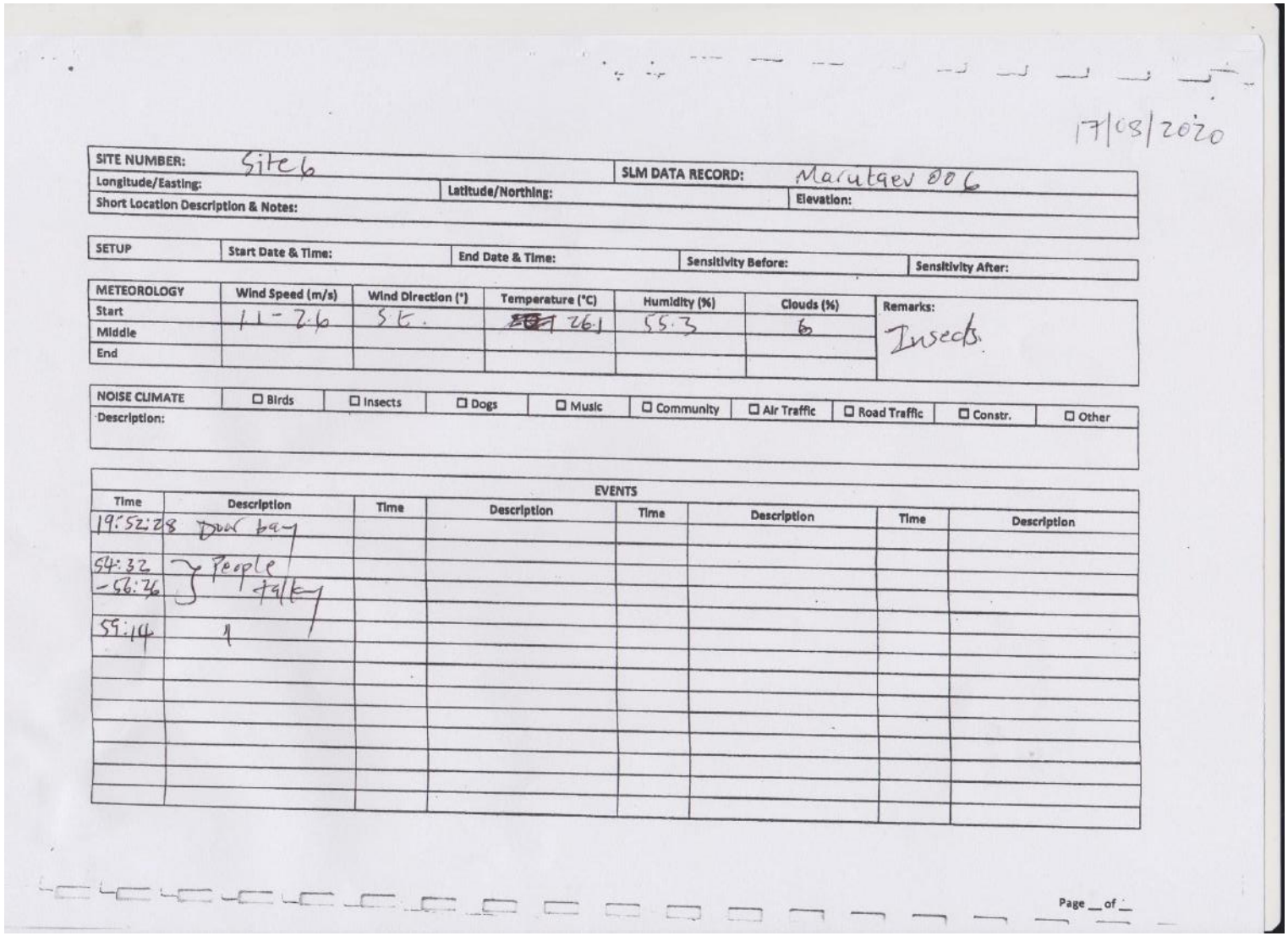
METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	11 - 3x7	S.E	25.1	55.1	6	- Insects the. - Windy.
Middle						
End						

NOISE CLIMATE	☐ Birds	☒ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
19:36:52							
42:15 -43:20	Vehicle pass						

Page __ of __



17/08/2020

SITE NUMBER:	Site 6		SLM DATA RECORD:	Marulaev 006
Longitude/Easting:		Latitude/Northing:		Elevation:
Short Location Description & Notes:				

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

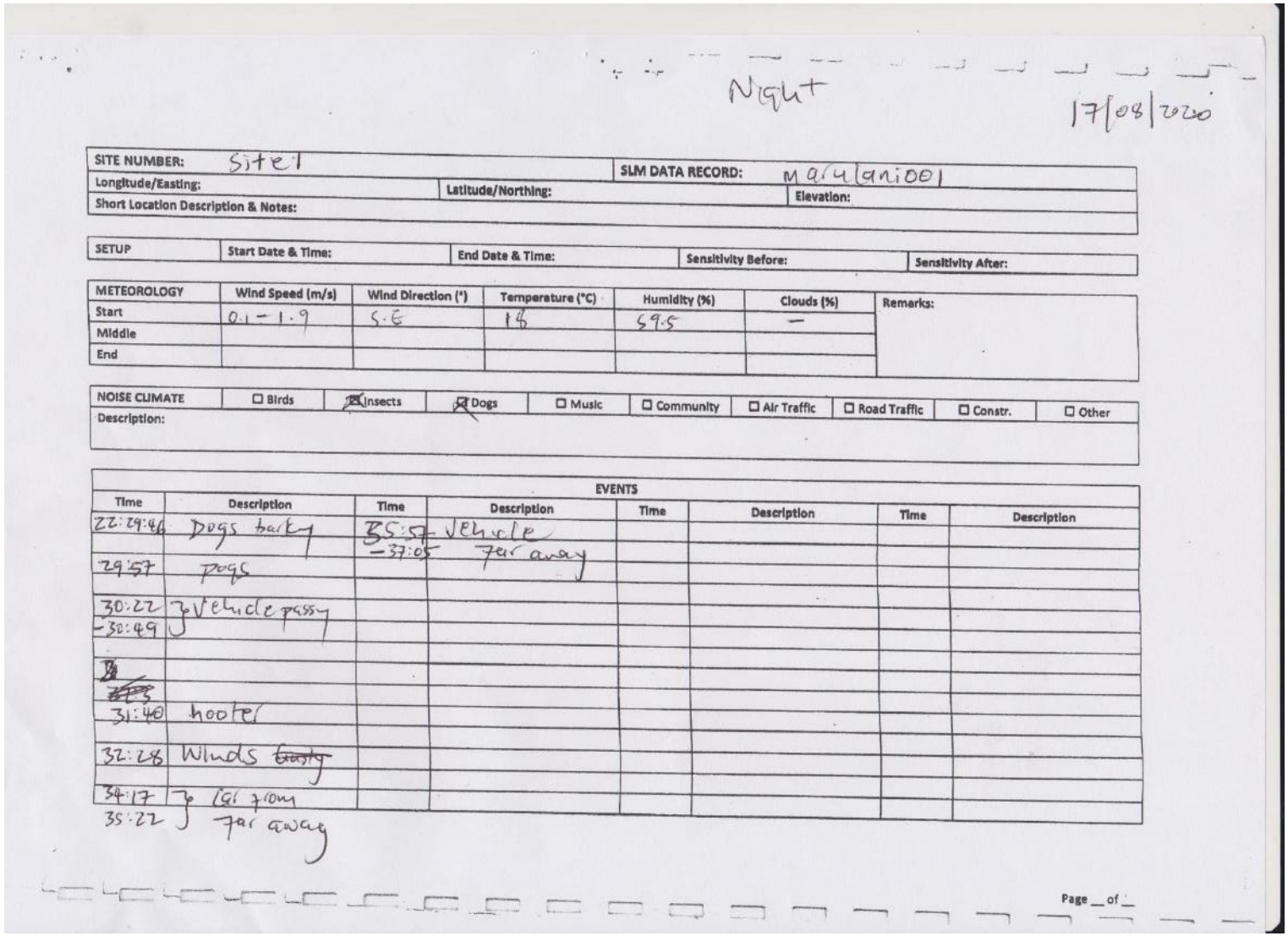
METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.1 - 2.6	S E.	26.1	55.3	6	Insects.
Middle						
End						

NOISE CLIMATE	☐ Birds	☐ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
19:52:28	Door bang						
54:32	People						
-56:36	talking						
59:14	"						

Page __ of __



Night

17/08/2020

SITE NUMBER: Site1			SLM DATA RECORD: M a r u l a n i 0 0 1		
Longitude/Easting:		Latitude/Northing:		Elevation:	
Short Location Description & Notes:					

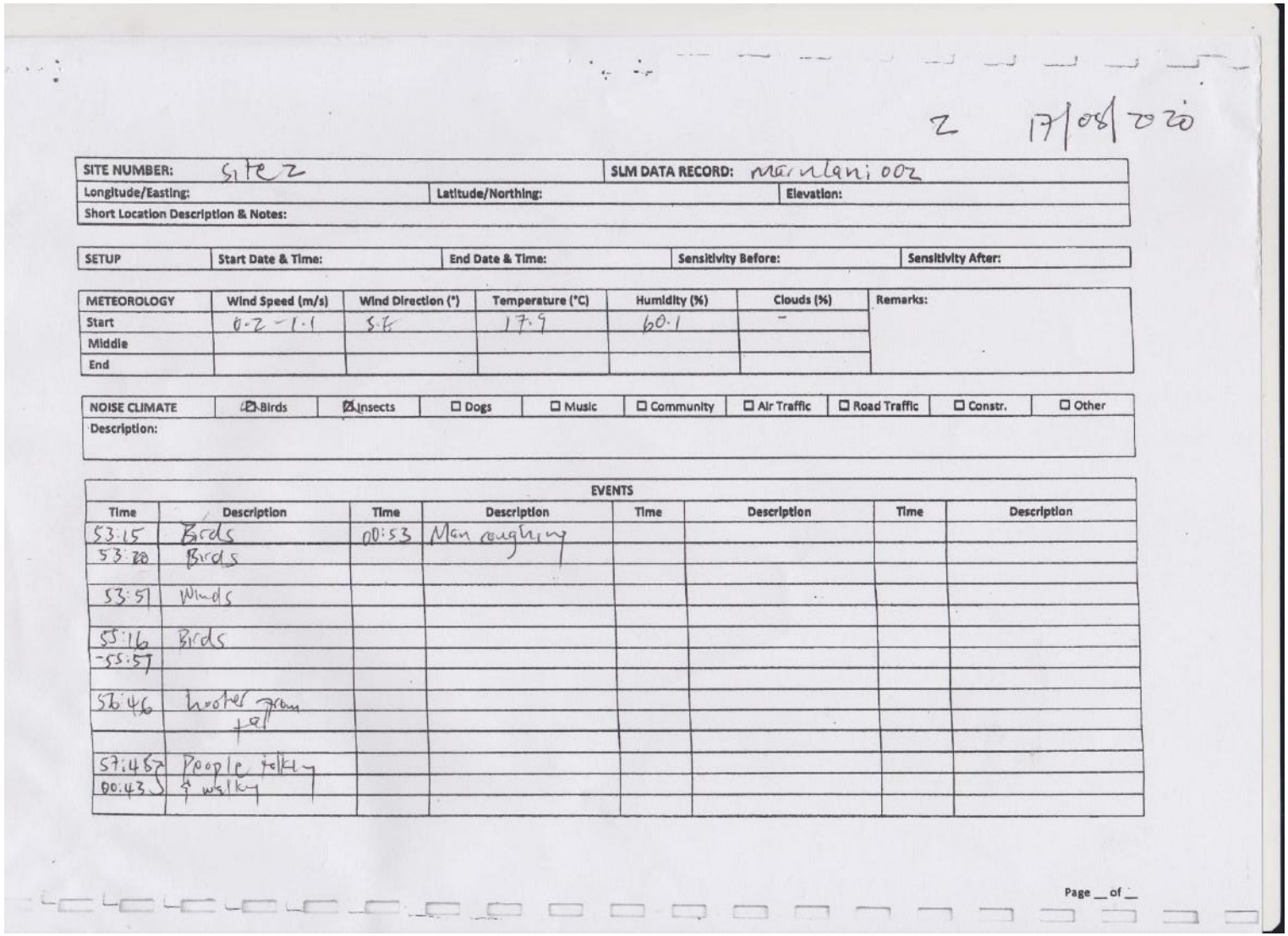
SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	0.1 - 1.9	S.E	18	59.5	—	
Middle						
End						

NOISE CLIMATE	☐ Birds	☒ Insects	☒ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS							
Time	Description	Time	Description	Time	Description	Time	Description
22:29:46	Dogs barking	35:57 - 37:05	Vehicle far away				
29:57	Dogs						
30:22 - 30:49	Vehicle passy						
31:40	hooter						
32:28	Winds ~~busy~~						
34:17 - 35:22	Vehicle from far away						

Page __ of __



2 17/08/2020

SITE NUMBER:	Site 2	SLM DATA RECORD:	Marulani 002
Longitude/Easting:	Latitude/Northing:	Elevation:	
Short Location Description & Notes:			

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	0.2 - 1.1	S.E	17.9	60.1	-	
Middle						
End						

NOISE CLIMATE	☒ Birds	☒ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
53:15	Birds	00:53	Man coughing				
53:20	Birds						
53:57	Winds						
55:16	Birds						
-55:57							
56:46	Shooter from +9						
57:48	People talking & walking						
00:43							

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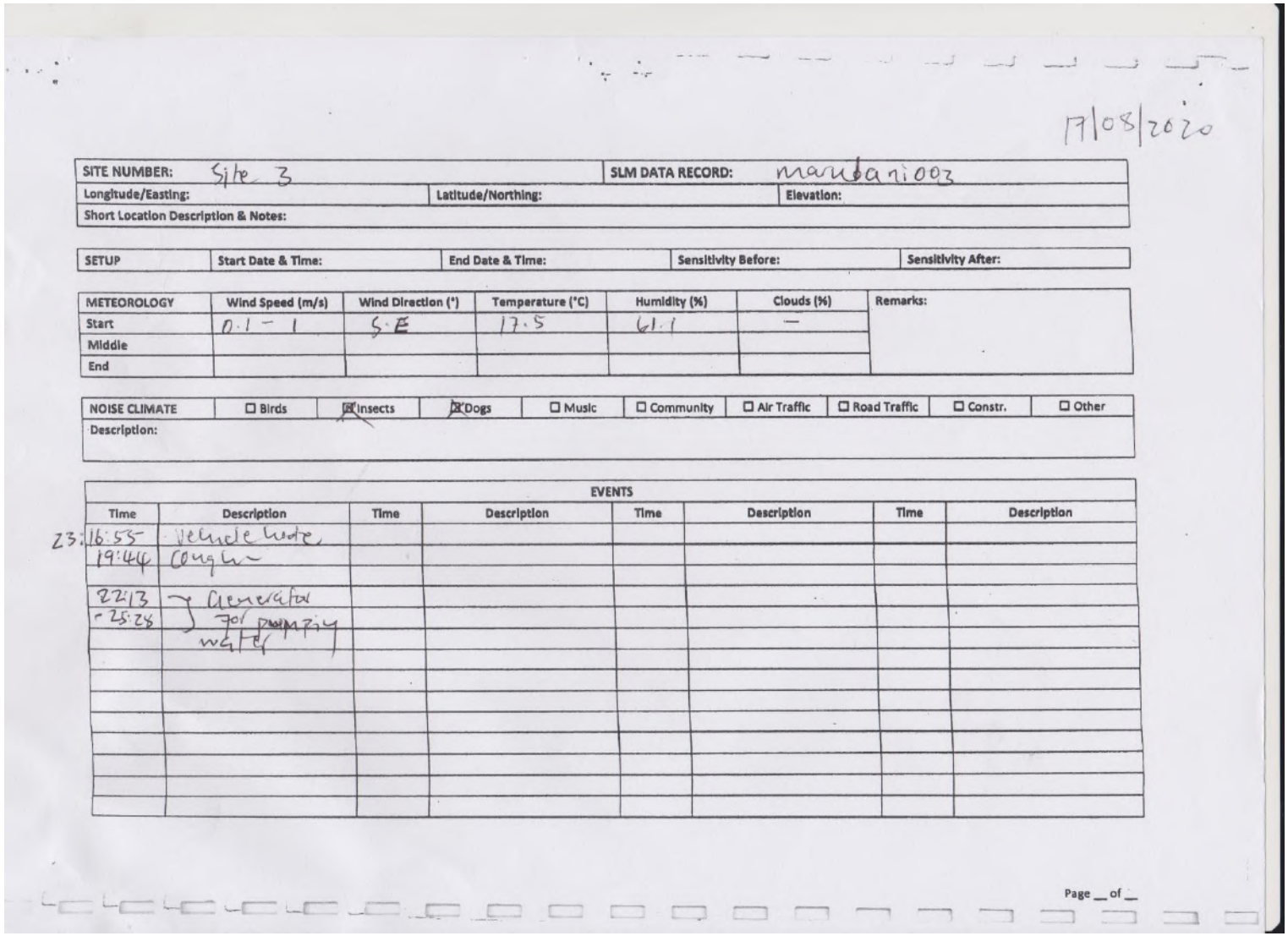


17/08/2020

SITE NUMBER:	Site 3			SLM DATA RECORD:	marubani003
Longitude/Easting:		Latitude/Northing:		Elevation:	
Short Location Description & Notes:					

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

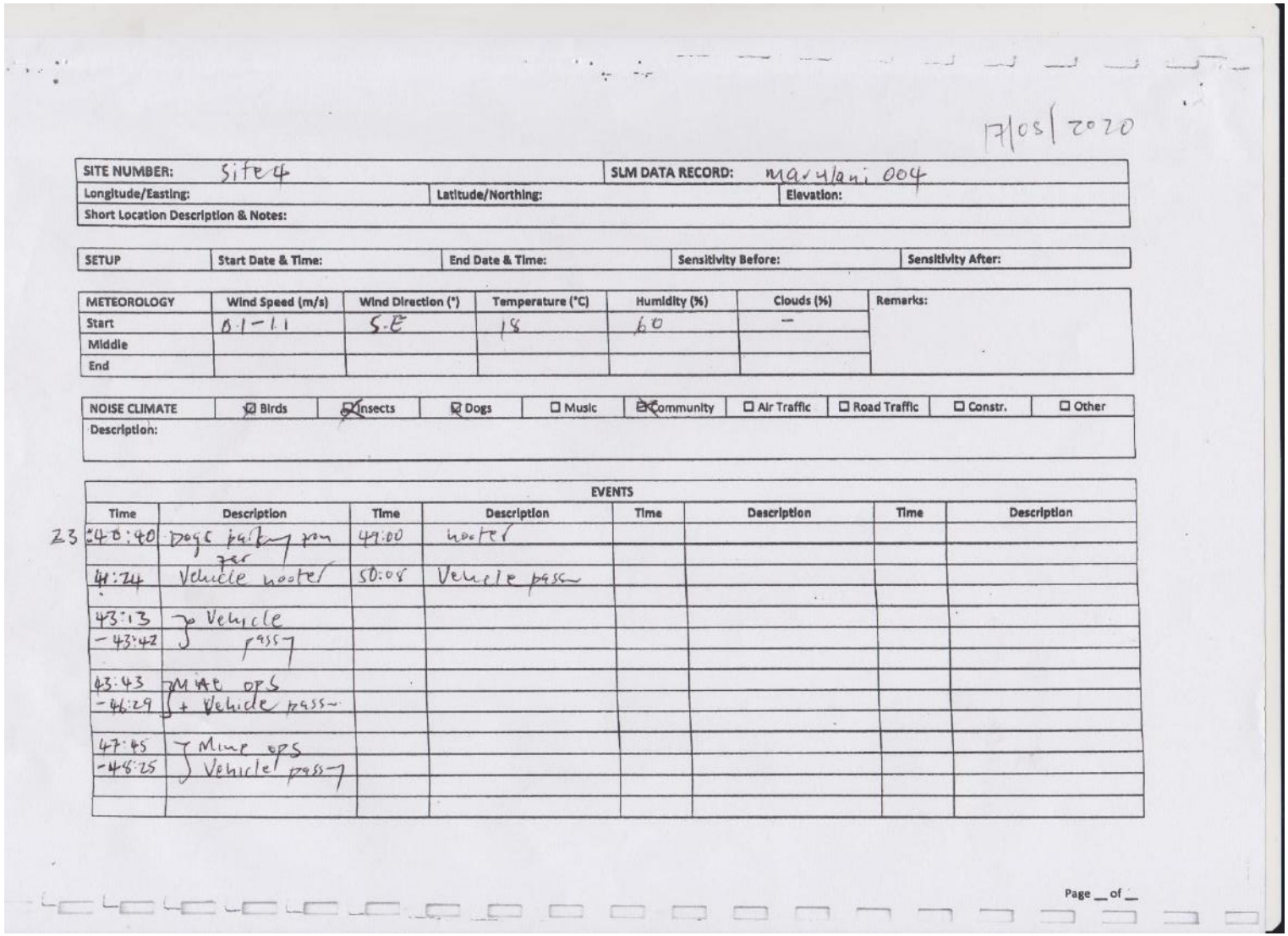
METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	0.1 – 1	S-E	17.5	61.1	—	
Middle						
End						

NOISE CLIMATE	☐ Birds	☒ Insects	☒ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
23:16:55	Vehicle hoote						
19:44	Cough						
22:13 – 25:26	Generator for pumping water						

Page __ of __



17/08/2020

SITE NUMBER:	Site 4			SLM DATA RECORD:	marulani 004
Longitude/Easting:		Latitude/Northing:		Elevation:	
Short Location Description & Notes:					

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

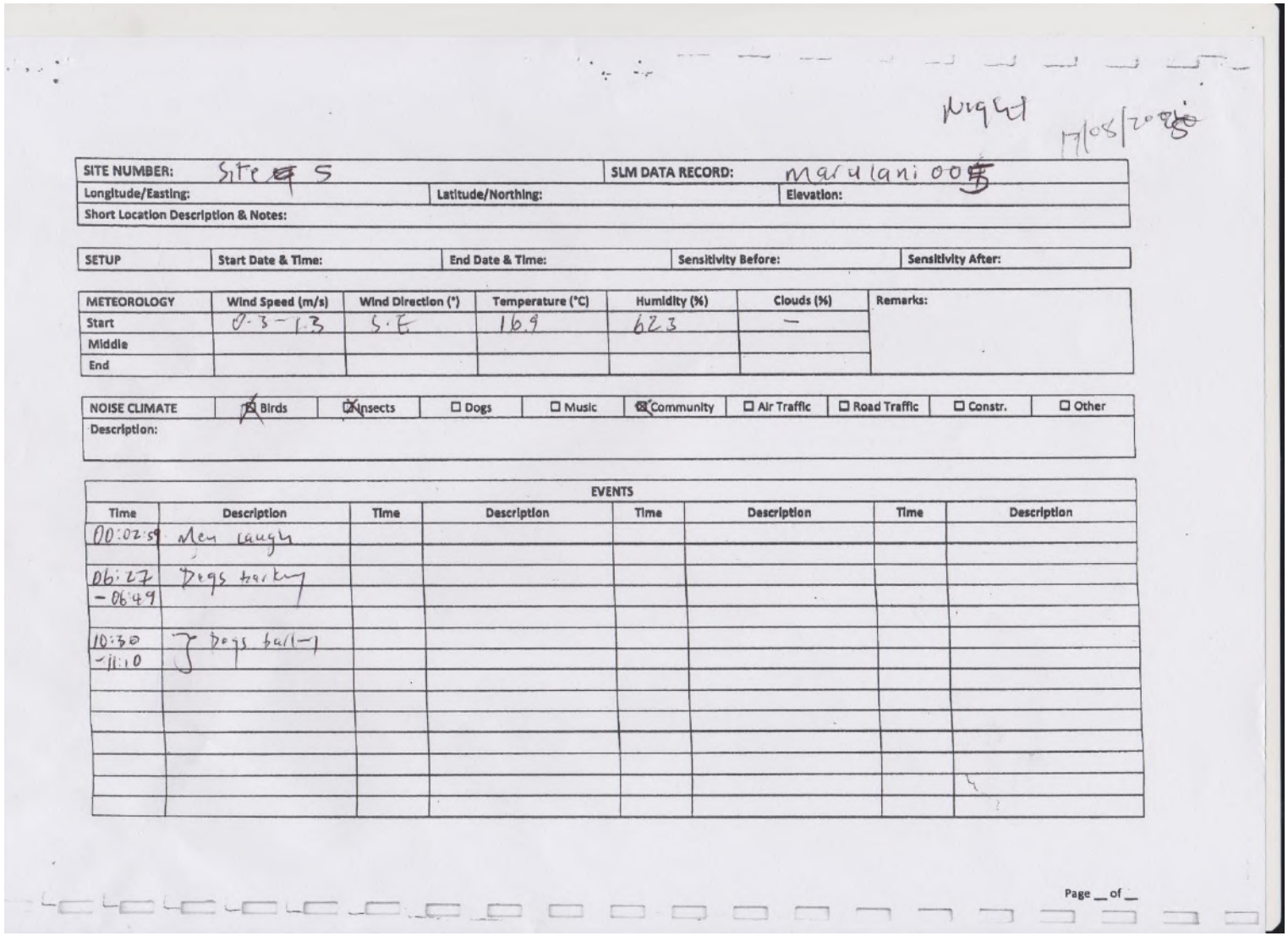
METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	0.1-1.1	S-E	18	60	–	
Middle						
End						

NOISE CLIMATE	☑ Birds	☒ Insects	☑ Dogs	☐ Music	☒ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
23 40:40	Dogs barking from far	49:00	Hooter				
41:24	Vehicle hooter	50:08	Vehicle pass				
43:13 – 43:42	Vehicle pass						
43:43 – 46:29	MMP ops + Vehicle pass						
47:45 – 48:25	MMP ops Vehicle pass						

Page __ of __



Night

17/05/2019

SITE NUMBER:	Site 5		SLM DATA RECORD:	Marulani 005
Longitude/Easting:		Latitude/Northing:		Elevation:
Short Location Description & Notes:				

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

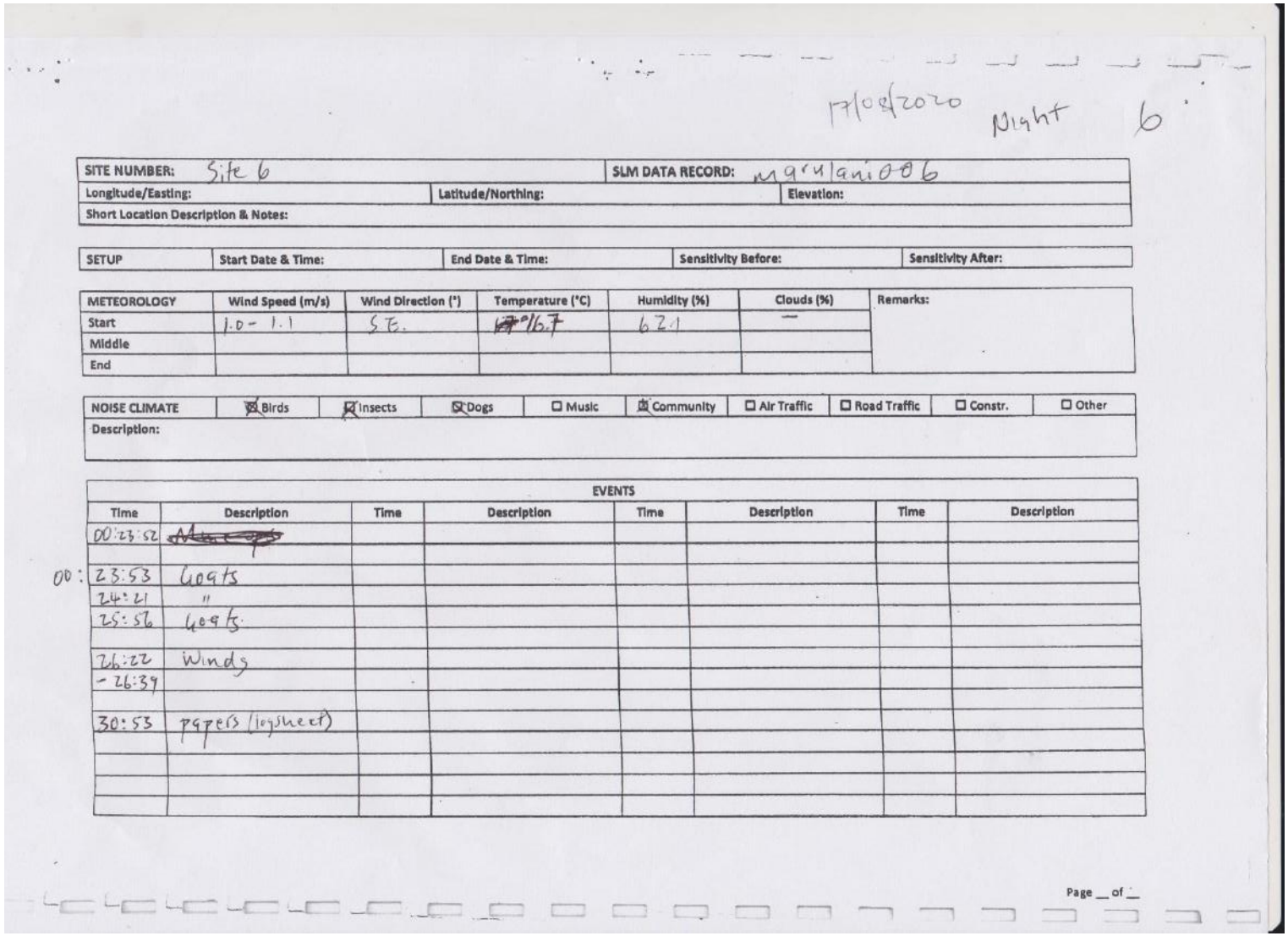
METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	0.3 - 1.3	S.E	16.9	62.3	—	
Middle						
End						

NOISE CLIMATE	☒ Birds	☒ Insects	☐ Dogs	☐ Music	☒ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
00:02:59	Men laugh						
06:27 - 06:49	Dogs barking						
10:30 - 11:10	Dogs barking						

Page __ of __



17/09/2020 Night 6

SITE NUMBER: Site 6		SLM DATA RECORD: Marula006
Longitude/Easting:	Latitude/Northing:	Elevation:
Short Location Description & Notes:		

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

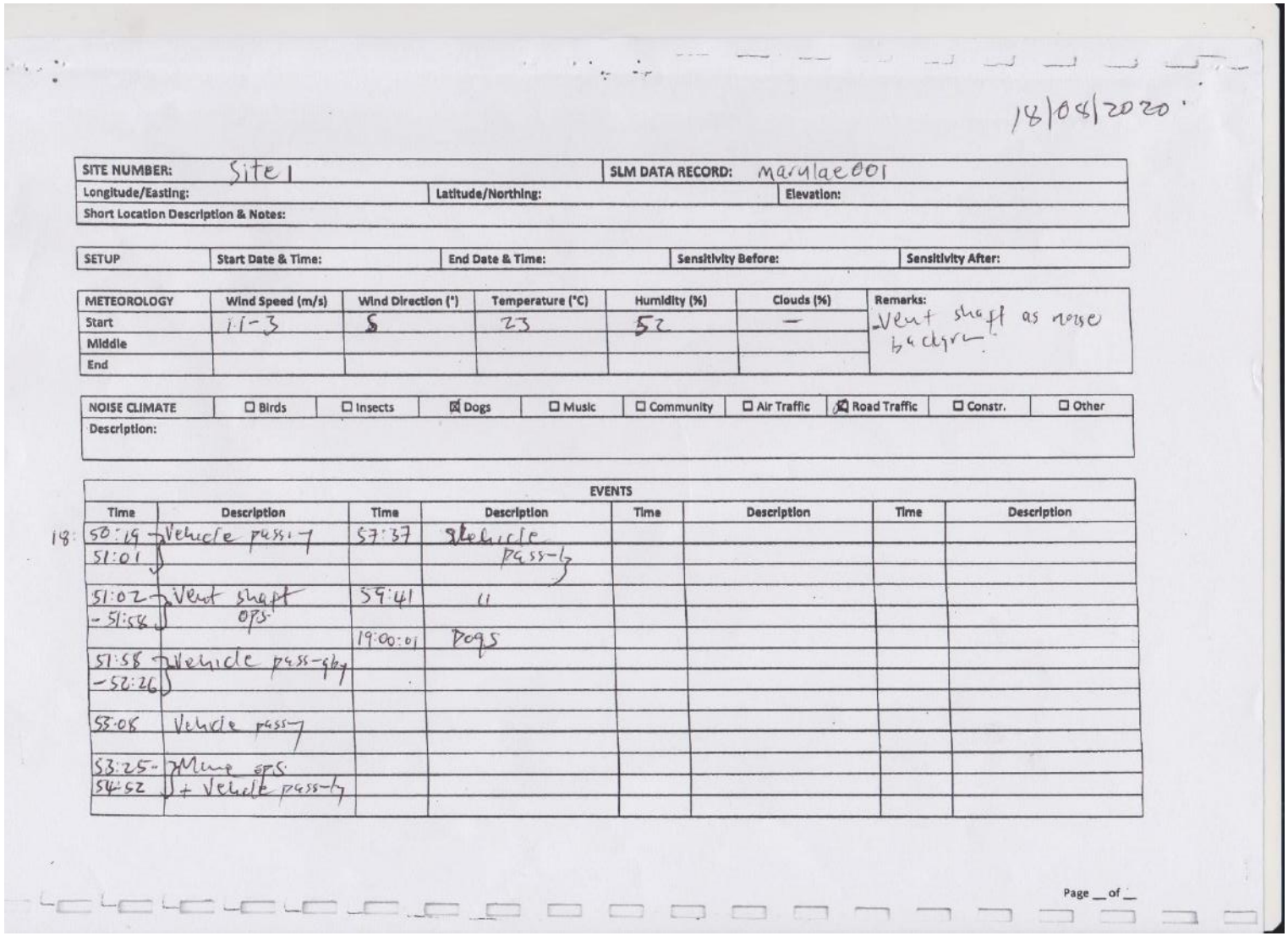
METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.0 - 1.1	SE.	~~17~~ 16.7	62.1	—	
Middle						
End						

NOISE CLIMATE	☒ Birds	☒ Insects	☒ Dogs	☐ Music	☒ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
00:23:52	~~Mark up~~						
00:23:53	Goats						
24:21	"						
25:56	Goats						
26:22	Winds						
- 26:39							
30:53	papers (logsheet)						

Page __ of __



18/08/2020.

SITE NUMBER:	Site 1	SLM DATA RECORD:	marulae001
Longitude/Easting:	Latitude/Northing:	Elevation:	
Short Location Description & Notes:			

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

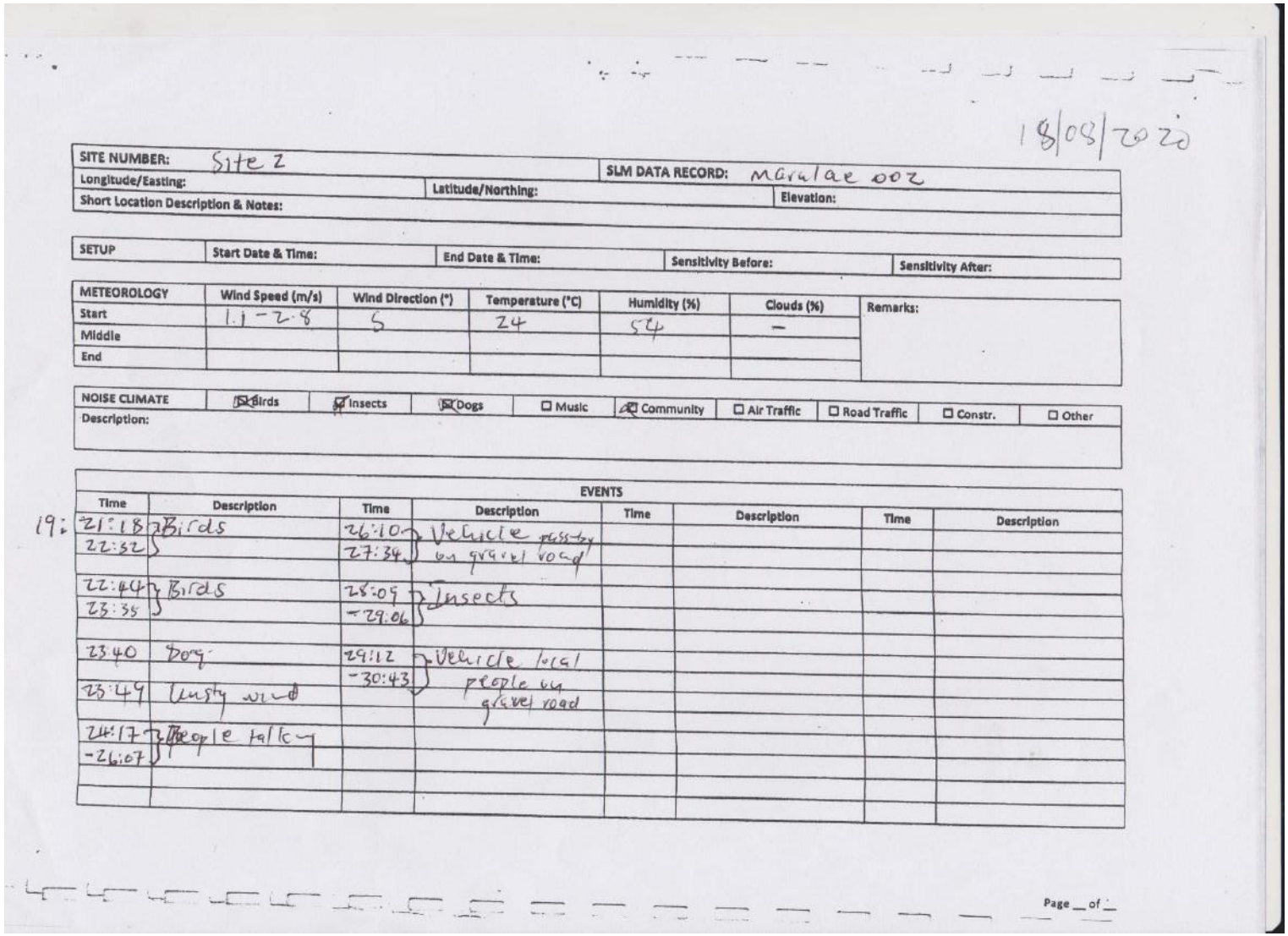
METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.1-3	S	23	52	—	-Vent shaft as noise background.
Middle						
End						

NOISE CLIMATE	☐ Birds	☐ Insects	☒ Dogs	☐ Music	☐ Community	☐ Air Traffic	☒ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
18: 50:19	Vehicle pass-by	57:37	Vehicle pass-by				
51:01							
51:02	Vent shaft ops	59:41	11				
- 51:58		19:00:01	Dogs				
51:58	Vehicle pass-by						
- 52:26							
53:08	Vehicle pass-by						
53:25 -	Mine ops						
54:52	+ Vehicle pass-by						

Page __ of __



18/08/2020

SITE NUMBER:	Site 2		SLM DATA RECORD:	Marulae 002
Longitude/Easting:		Latitude/Northing:		Elevation:
Short Location Description & Notes:				

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

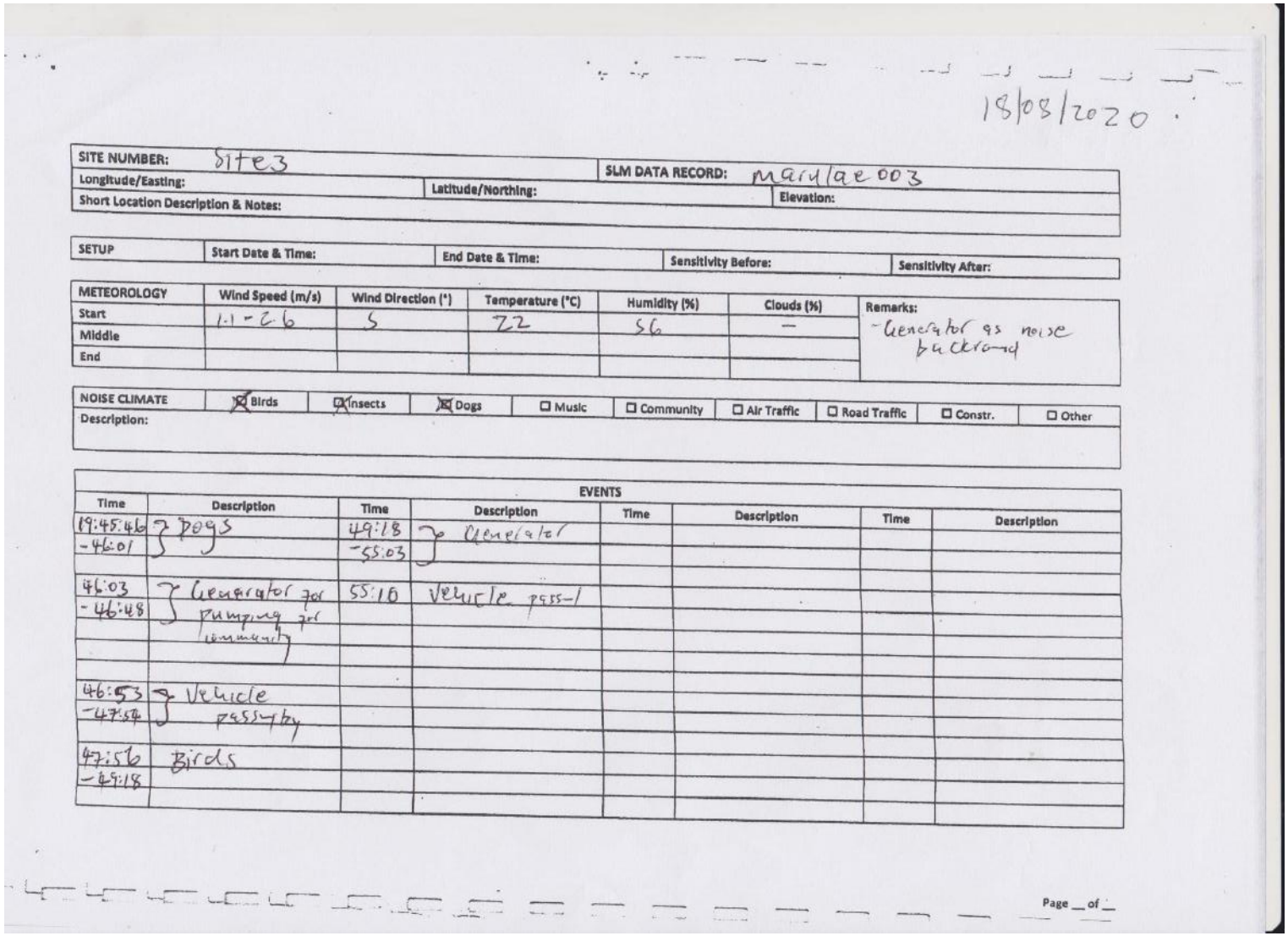
METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.1 - 2.8	S	24	54	—	
Middle						
End						

NOISE CLIMATE	☒ Birds	☒ Insects	☒ Dogs	☐ Music	☒ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
19: 21:18	Birds	26:10	Vehicle passby on gravel road				
22:32		27:34					
22:44	Birds	28:09	Insects				
23:35		-29:06					
23:40	Dog	29:12	Vehicle local people on gravel road				
23:49	Windy wind	-30:43					
24:17	People talking						
-26:07							

Page __ of __



18/08/2020.

SITE NUMBER: Site3			SLM DATA RECORD: marulae003	
Longitude/Easting:	Latitude/Northing:		Elevation:	
Short Location Description & Notes:				

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

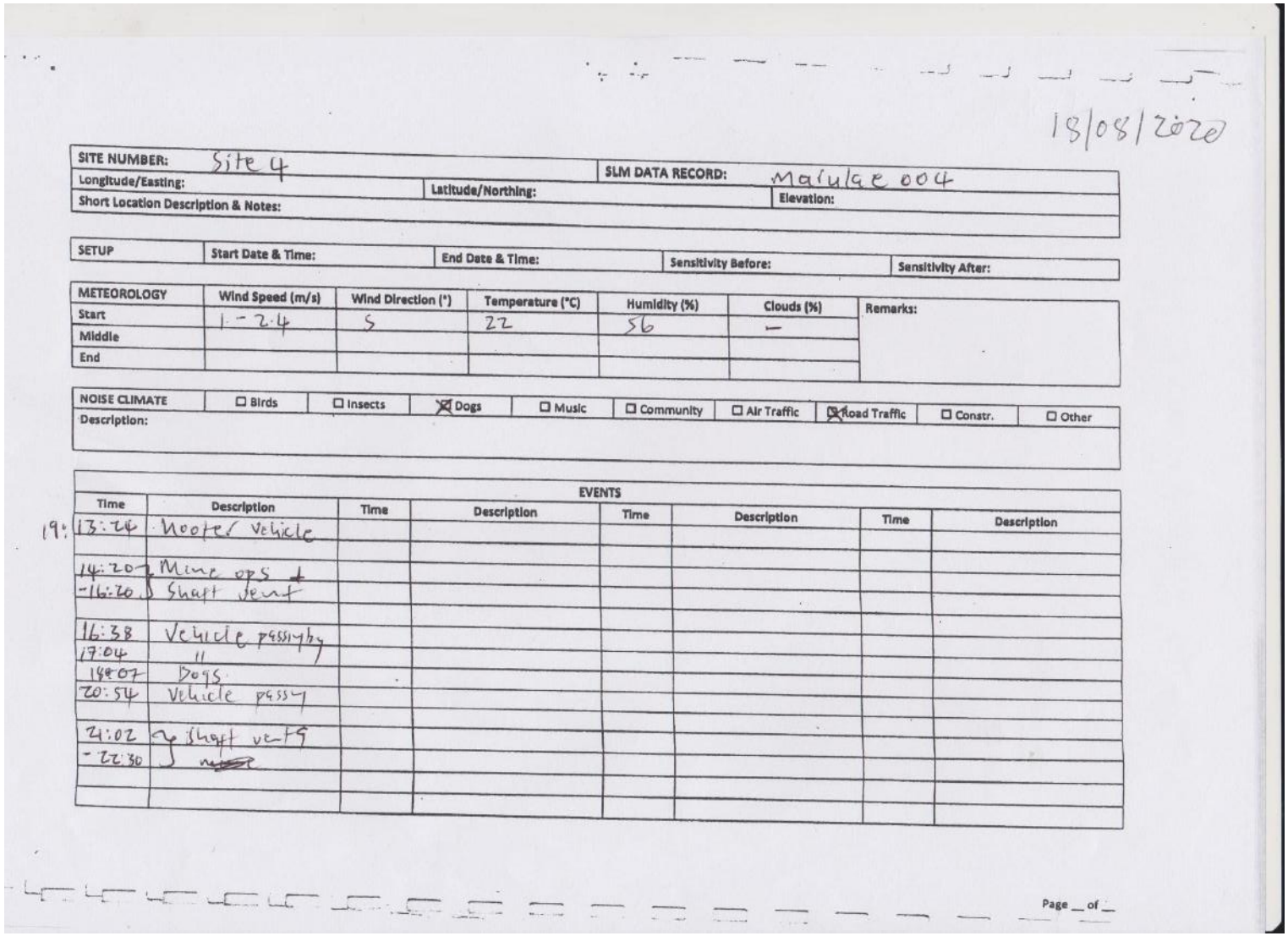
METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.1 - 2.6	S	22	56	—	- Generator as noise background
Middle						
End						

NOISE CLIMATE	☒ Birds	☒ Insects	☒ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
19:45:46 - 46:01	Dogs	49:18 - 55:03	Generator				
46:03 - 46:48	Generator for pumping for community	55:10	Vehicle pass-1				
46:53 - 47:54	Vehicle pass-by						
47:56 - 49:18	Birds						

Page __ of __



18/08/2020

SITE NUMBER:	Site 4			SLM DATA RECORD:	Marulae 004
Longitude/Easting:		Latitude/Northing:		Elevation:	
Short Location Description & Notes:					

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1-2.4	S	22	56	—	
Middle						
End						

NOISE CLIMATE	☐ Birds	☐ Insects	☒ Dogs	☐ Music	☐ Community	☐ Air Traffic	☒ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
19: 13:24	Hooter/ Vehicle						
14:20 – 16:20	Mine ops + Shaft vent						
16:38	Vehicle passing by						
17:04	"						
18:07	Dogs						
20:54	Vehicle passing						
21:02 – 22:30	Shaft vents						

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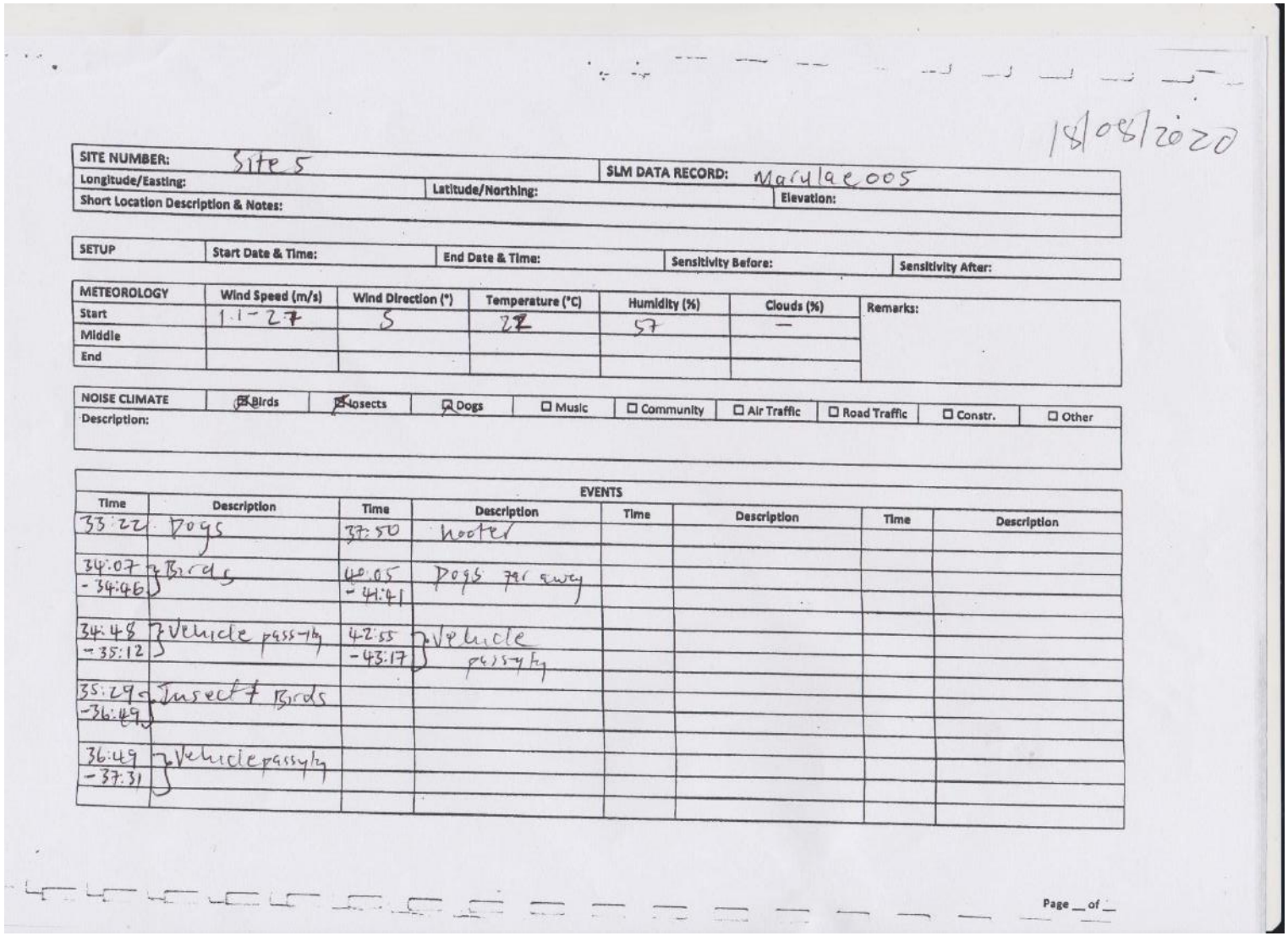

18/08/2020

SITE NUMBER:	Site 5		SLM DATA RECORD:	Marula e005
Longitude/Easting:		Latitude/Northing:		Elevation:
Short Location Description & Notes:				

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.1-2.7	S	27	57	—	
Middle						
End						

NOISE CLIMATE	☒ Birds	☒ Insects	☒ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
33:22	Dogs	37:50	hooter				
34:07 - 34:46	Birds	40:05 - 41:41	Dogs far away				
34:48 - 35:12	Vehicle passing	42:55 - 43:17	Vehicle passing				
35:29 - 36:49	Insect + Birds						
36:49 - 37:31	Vehicle passing						

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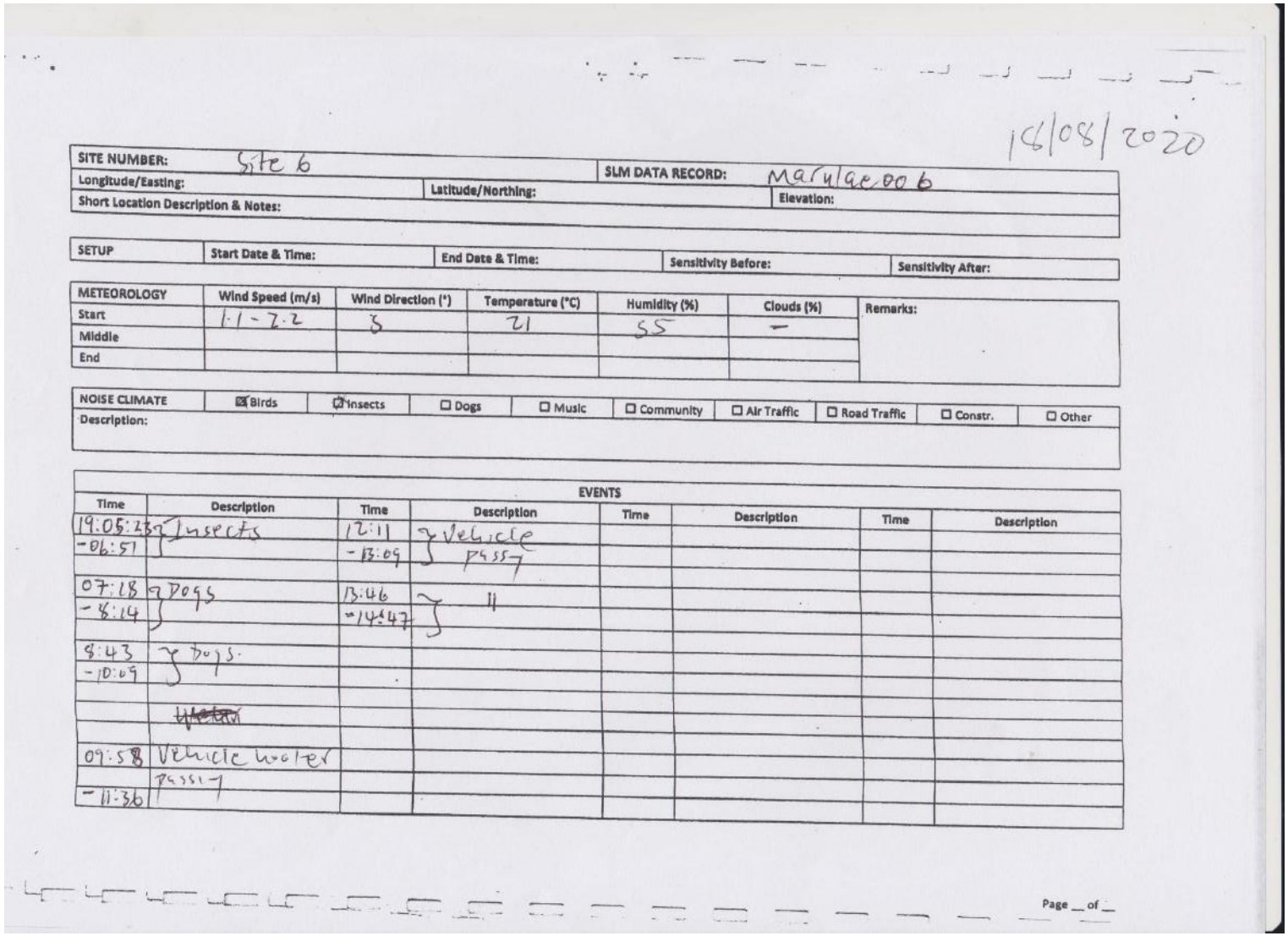


16/08/2020

SITE NUMBER:	Site 6		SLM DATA RECORD:	Marulaeeb 6
Longitude/Easting:		Latitude/Northing:		Elevation:
Short Location Description & Notes:				

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

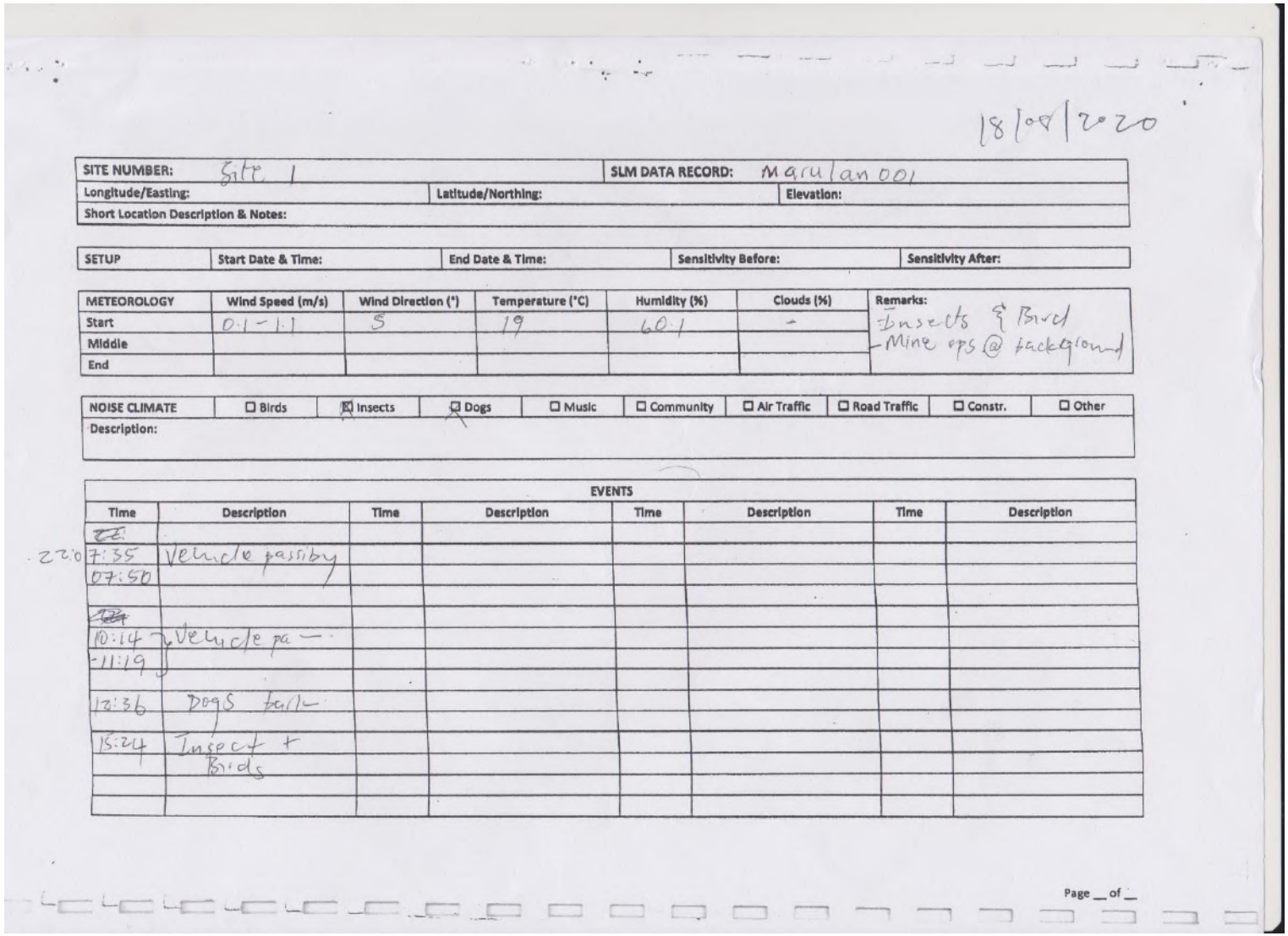
METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.1 - 2.2	S	21	55	—	
Middle						
End						

NOISE CLIMATE	☒ Birds	☐ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
19:05:23	Insects	12:11	Vehicle				
- 06:51		- 13:09	passby				
07:18	Dogs	13:46	"				
- 8:14		- 14:47					
8:43	Dogs.						
- 10:09							
	~~Water~~						
09:58	Vehicle water						
	passby						
- 11:36							

Page __ of __



18/08/2020

SITE NUMBER:	Site 1		SLM DATA RECORD:	Marulan 001
Longitude/Easting:		Latitude/Northing:		Elevation:
Short Location Description & Notes:				

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	0.1 - 1.1	S	19	60.1	-	- Insects & Bird - Mine ops @ background
Middle						
End						

NOISE CLIMATE	☐ Birds	☒ Insects	☑ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
22:07:35	Vehicle passby						
07:50							
10:14 - 11:19	Vehicle pa —						
13:36	Dogs bark						
15:24	Insect + Birds						

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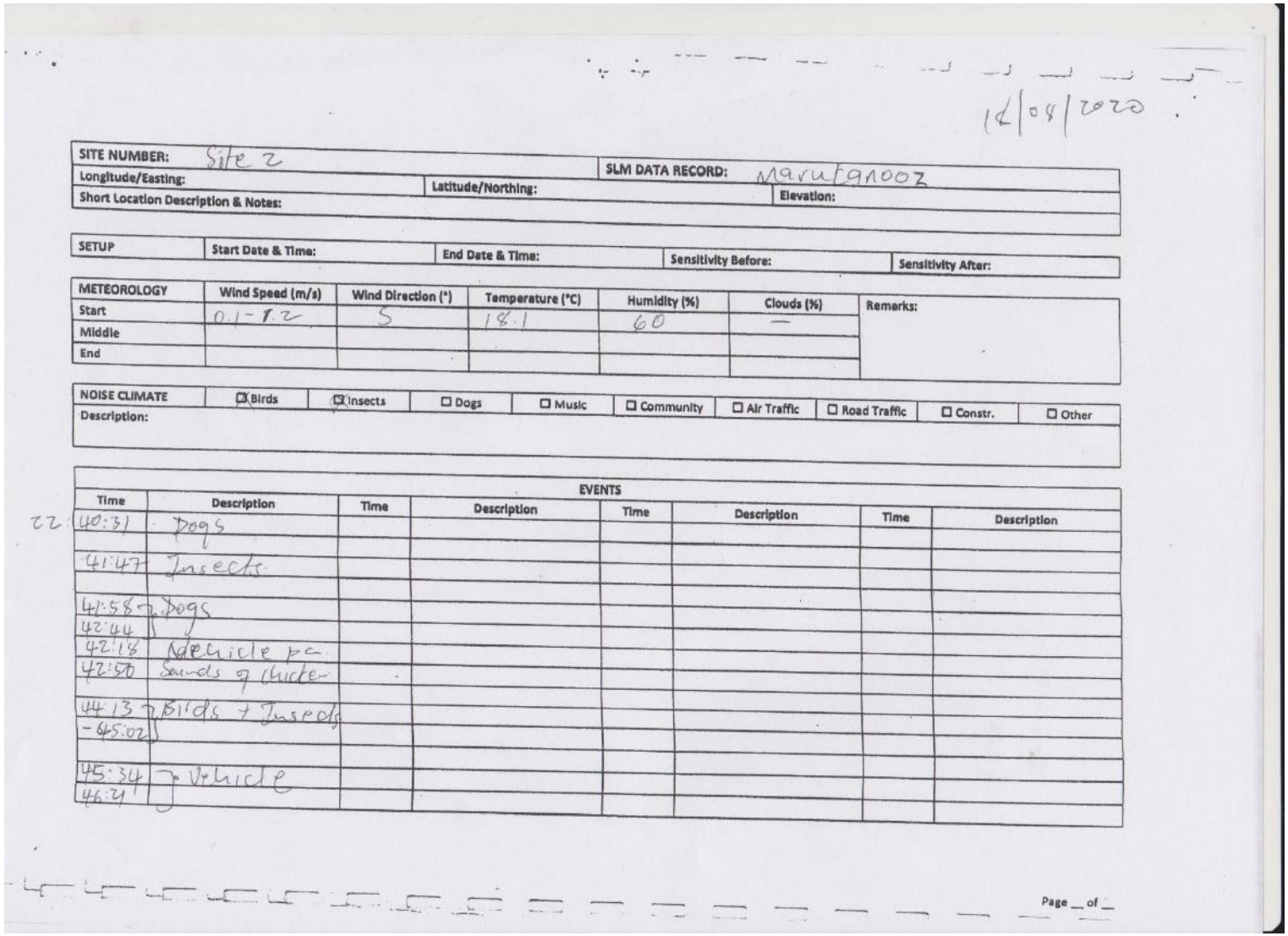

14/08/2020

SITE NUMBER:	Site 2		SLM DATA RECORD:	Marulan002
Longitude/Easting:		Latitude/Northing:		Elevation:
Short Location Description & Notes:				

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	0.1-1.2	S	18.1	60	—	
Middle						
End						

NOISE CLIMATE	☒ Birds	☒ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
22 40:31	Dogs						
41:47	Insects						
41:58 →	Dogs						
42:44							
42:18	Vehicle pa						
42:50	Sounds of chicke						
44:13 →	Birds + Insects						
- 45:02							
45:34 →	Vehicle						
46:21							

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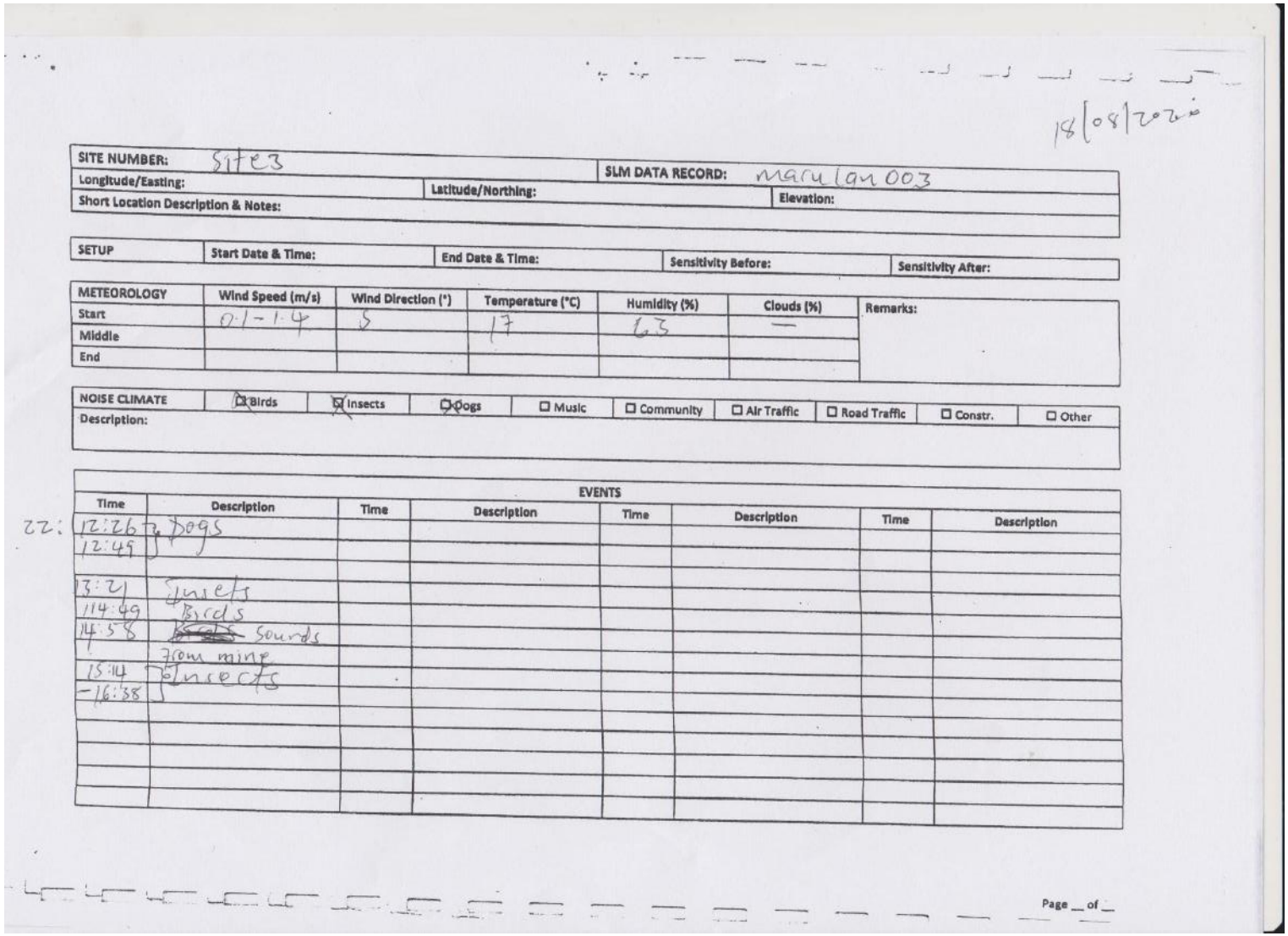

18/08/2020

SITE NUMBER:	Site3		SLM DATA RECORD:	marulan003
Longitude/Easting:		Latitude/Northing:		Elevation:
Short Location Description & Notes:				

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	0.1-1.4	S	17	63	—	
Middle						
End						

NOISE CLIMATE	☒ Birds	☒ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
12:26	Dogs						
12:49							
13:21	Insects						
14:49	Birds						
14:58	~~Birds~~ Sounds from mine						
15:14	Insects						
16:38							

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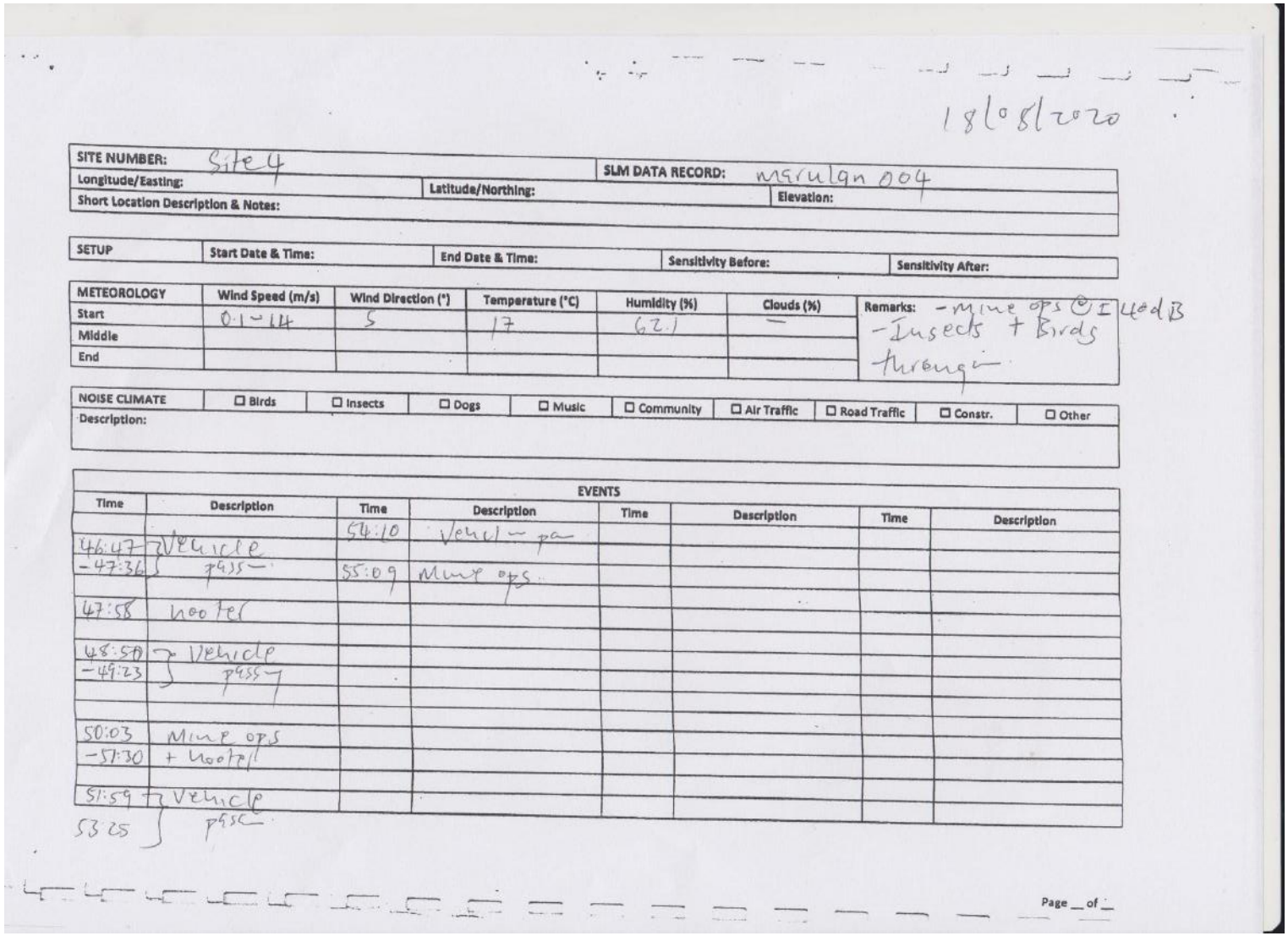

18/08/2020

SITE NUMBER: Site 4			SLM DATA RECORD: mgrulqn 004
Longitude/Easting:	Latitude/Northing:	Elevation:	
Short Location Description & Notes:			

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks: - mine ops @ I 40dB - Insects + Birds through
Start	0.1 ~ 14	S	17	62.1	—	
Middle						
End						

NOISE CLIMATE	☐ Birds	☐ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
		54:10	Vehicle pass				
46:47 – 47:36	Vehicle pass	55:09	Mine ops				
47:58	hooter						
48:50 – 49:23	Vehicle pass						
50:03 – 51:30	Mine ops + hooter						
51:59 – 53:25	Vehicle pass						

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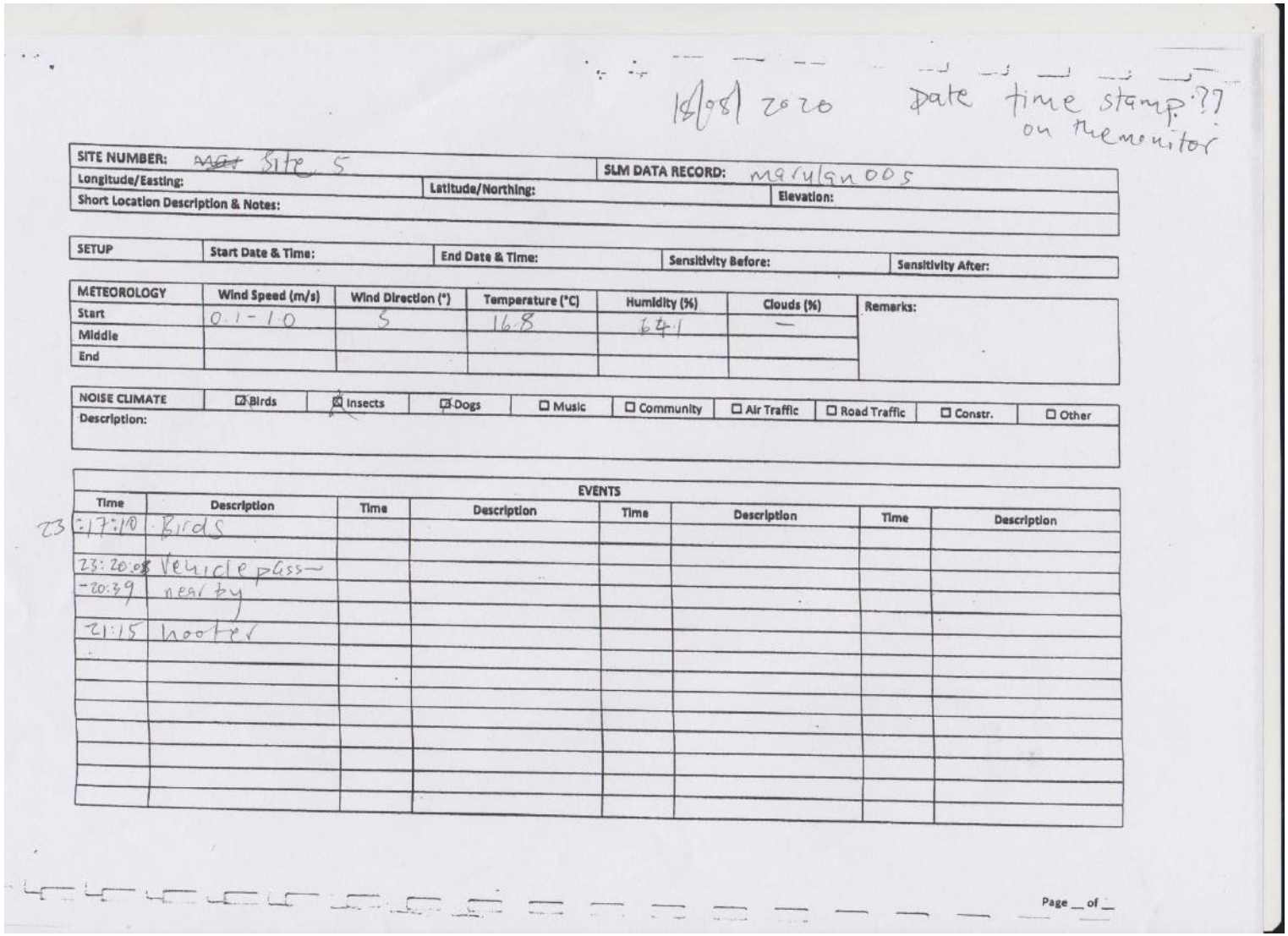

18/08/2020 date time stamp ?? on the monitor

SITE NUMBER: ~~MGT~~ Site 5		SLM DATA RECORD: marulan005
Longitude/Easting:	Latitude/Northing:	Elevation:
Short Location Description & Notes:		

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	0.1-1.0	S	16.8	64	—	
Middle						
End						

NOISE CLIMATE	☑ Birds	☑ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
23:17:10	Birds						
23:20:08	Vehicle pass-						
-20:39	near by						
21:15	hooter						

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Facing north

Facing east

Facing south

Facing west

Figure 22: Photographs of environmental noise survey Site 1

Facing north

Facing east

Facing south

Facing west

Figure 23: Photographs of environmental noise survey Site 2

Facing north

Facing east

Facing south

Facing west

Figure 24: Photographs of environmental noise survey Site 3

Facing north

Facing east

Facing south

Facing west

Figure 25: Photographs of environmental noise survey Site 4

Facing north

Facing east

Facing south

Facing west

Figure 26: Photographs of environmental noise survey Site 5

Facing north

Facing east

Facing south

Facing west

Figure 27: Photographs of environmental noise survey Site 6

Appendix E – Time-series, Statistical, and Frequency Spectrum Results

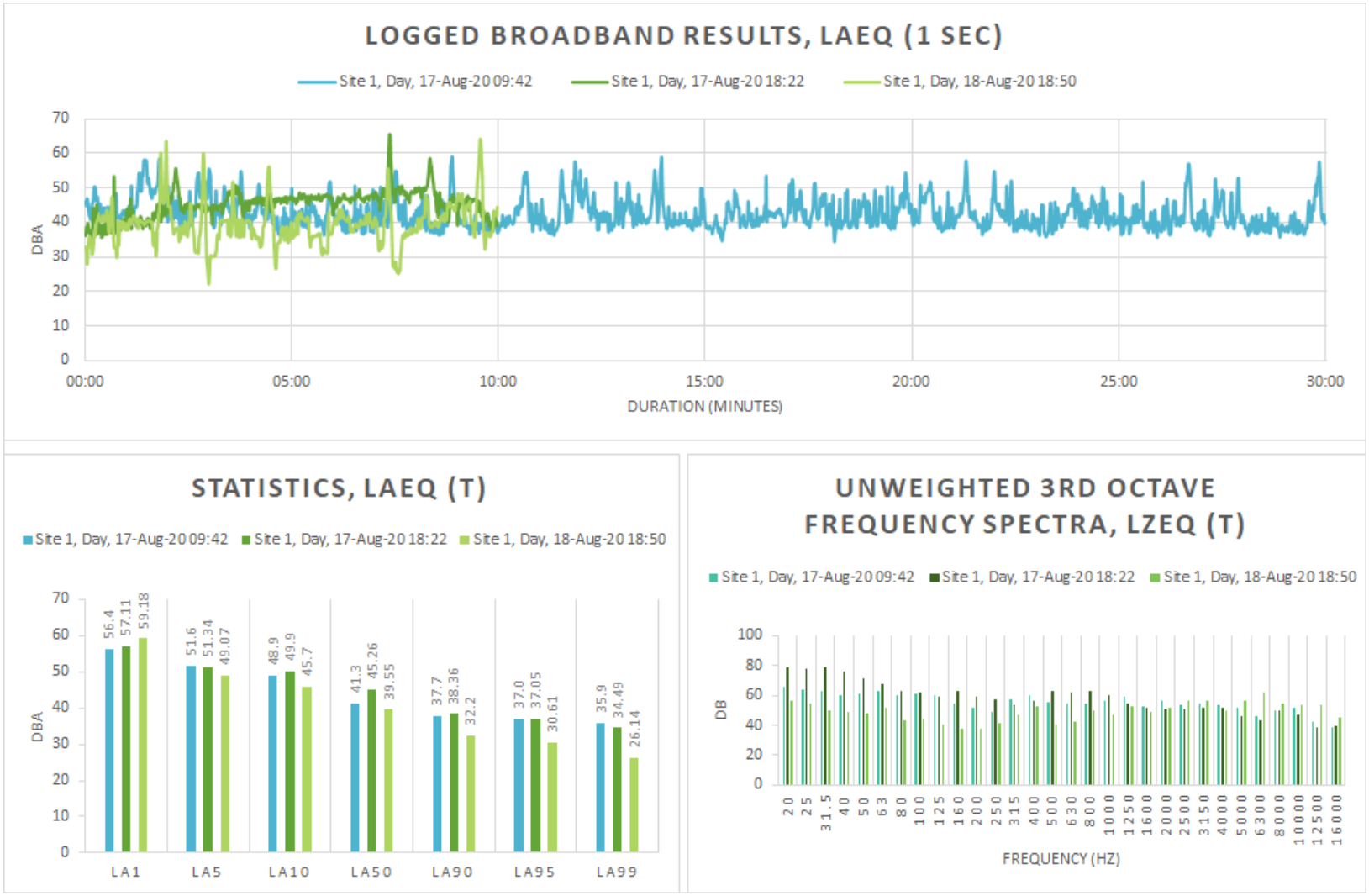

Figure 28: Detailed day-time survey results for Site 1

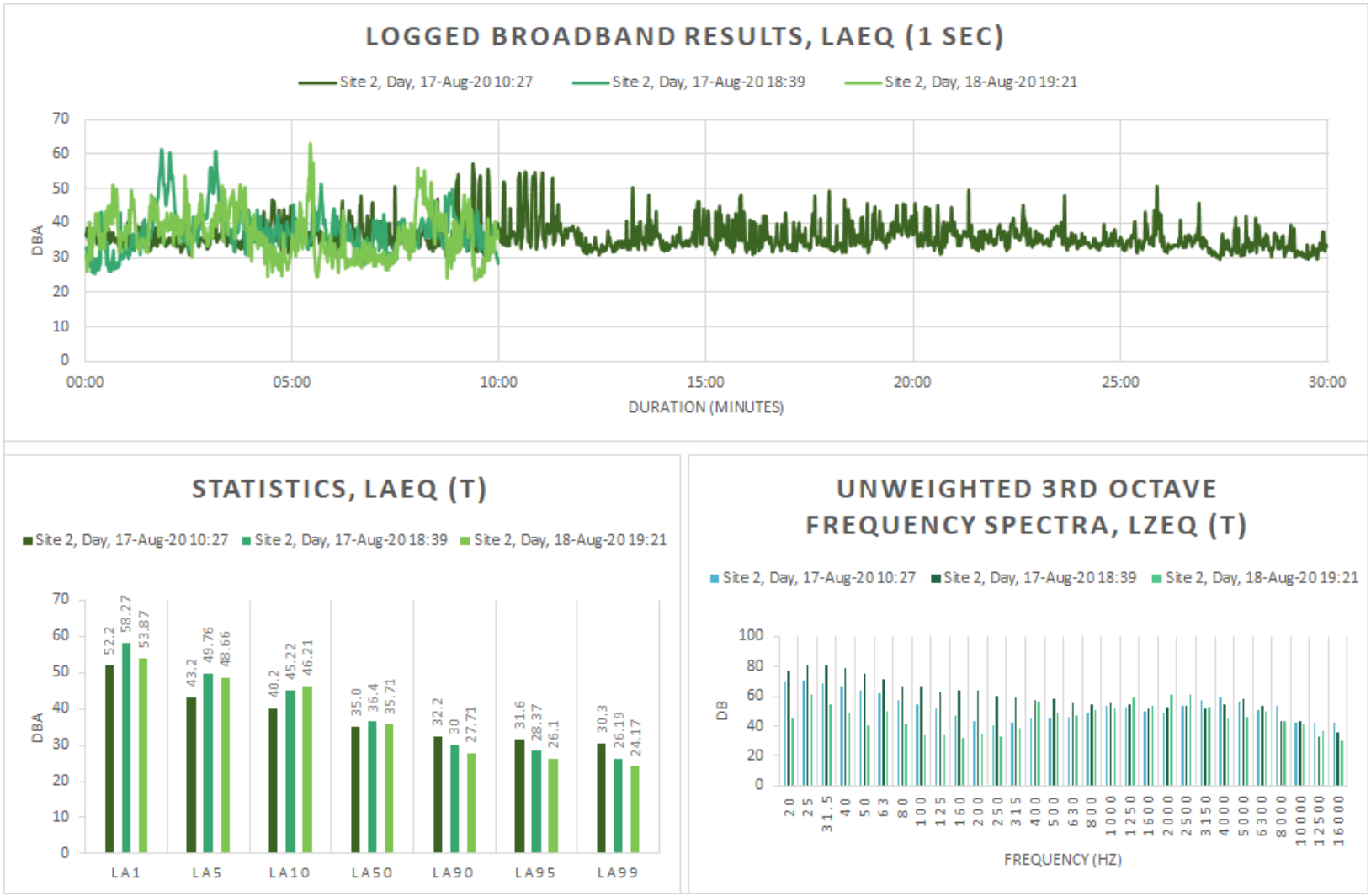

Figure 29: Detailed day-time survey results for Site 2

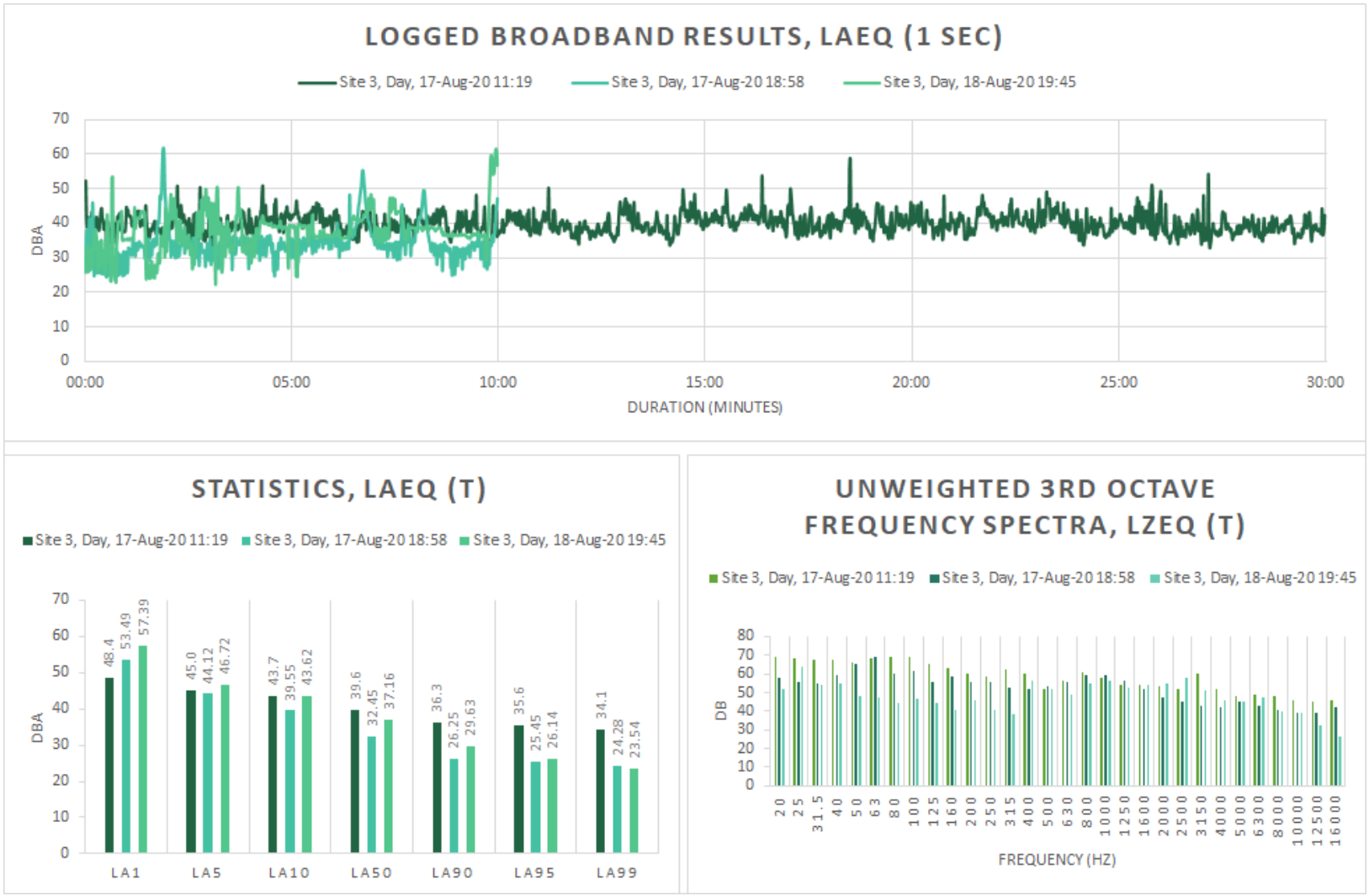

Figure 30: Detailed day-time survey results for Site 3

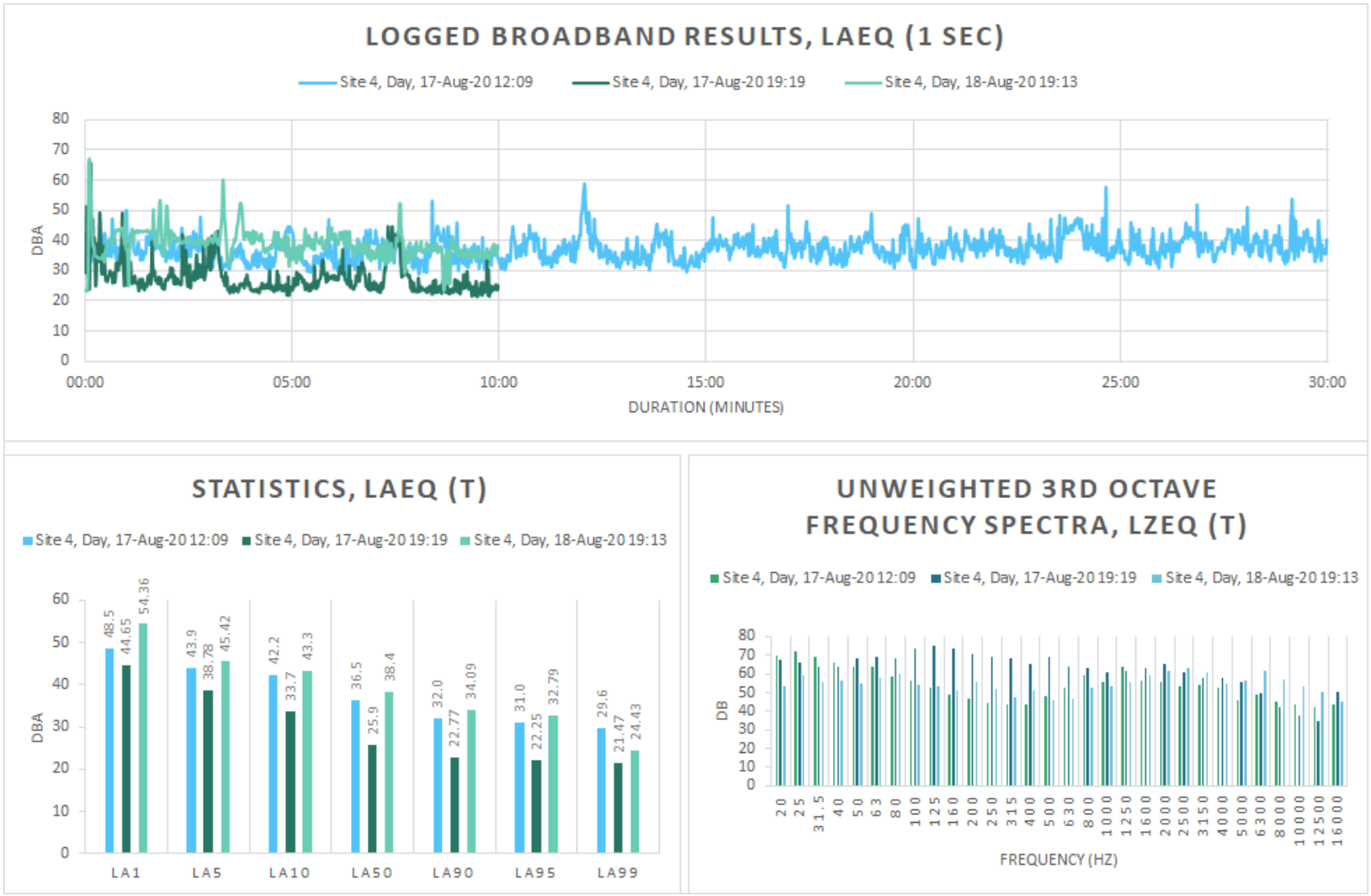

Figure 31: Detailed day-time survey results for Site 4

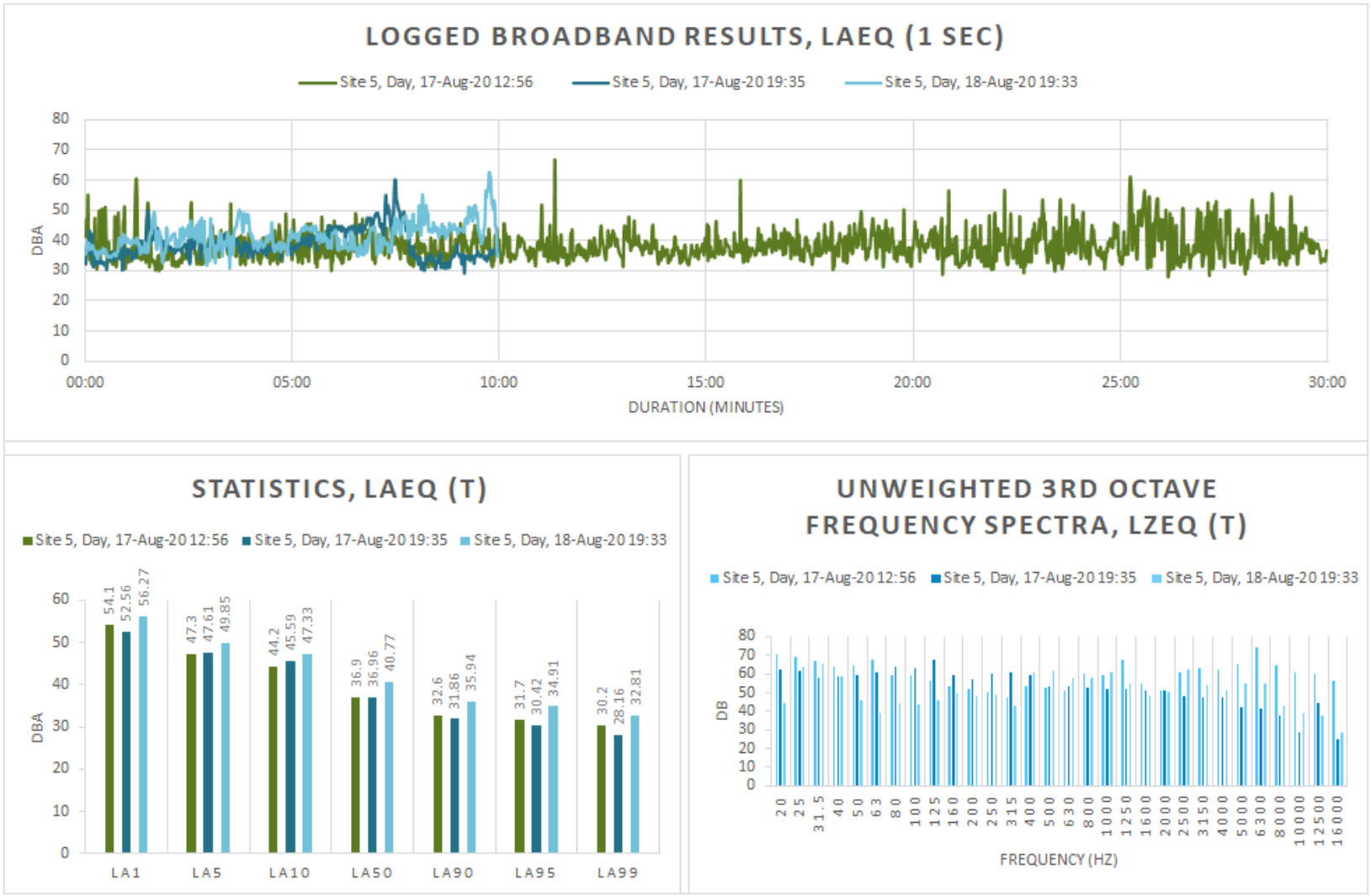

Figure 32: Detailed day-time survey results for Site 5

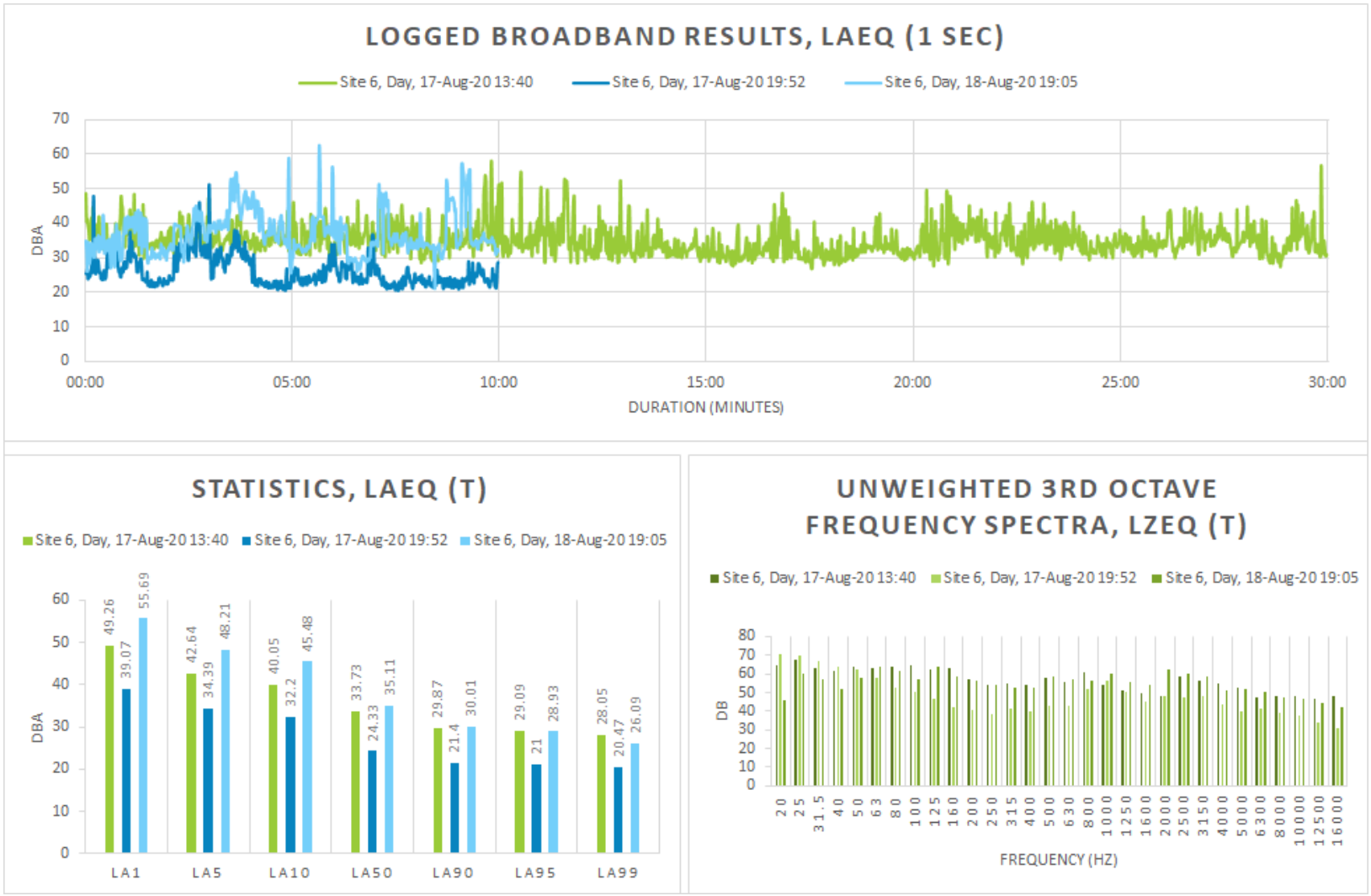

Figure 33: Detailed day-time survey results for Site 6

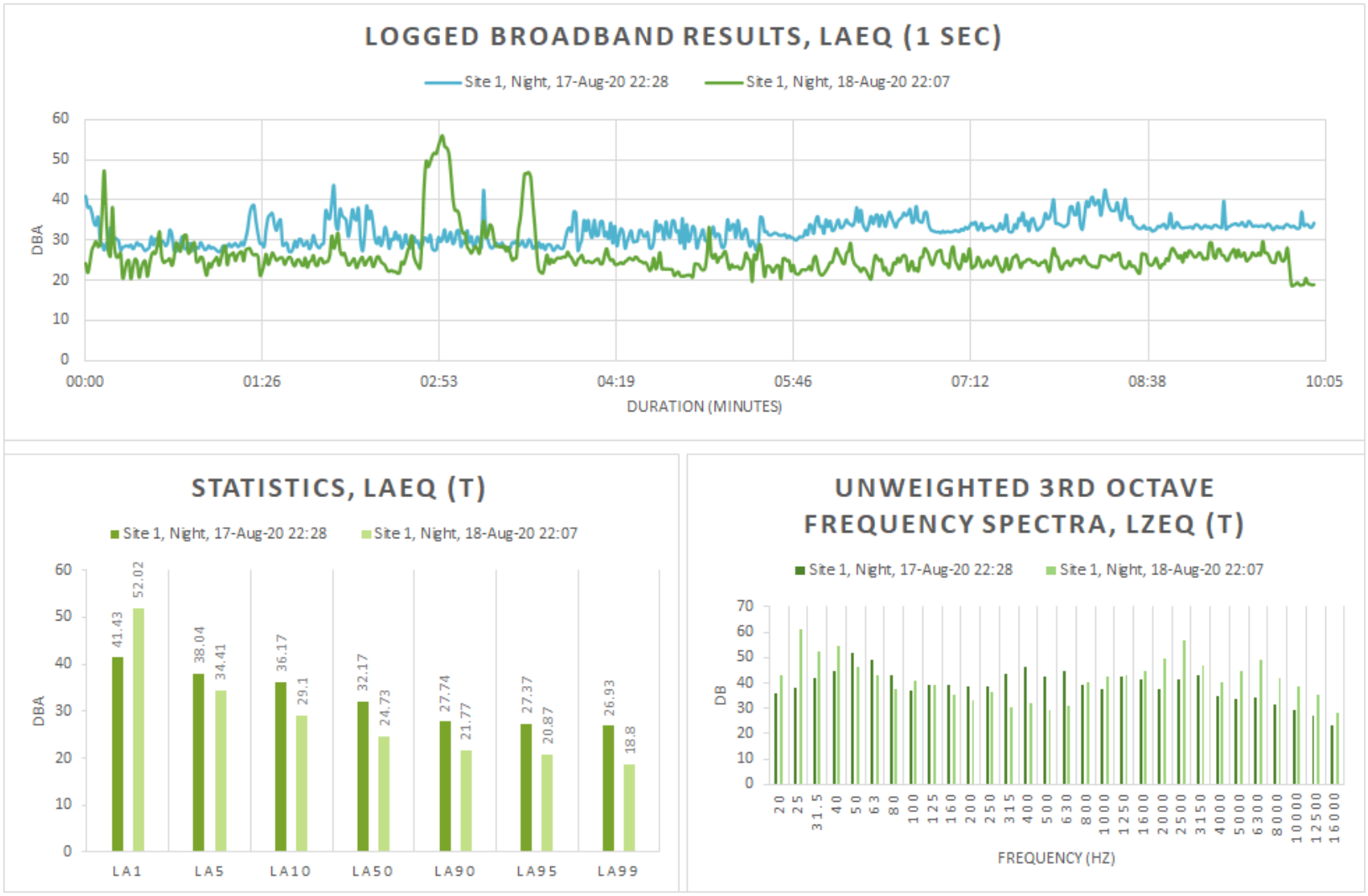

Figure 34: Detailed night-time survey results for Site 1

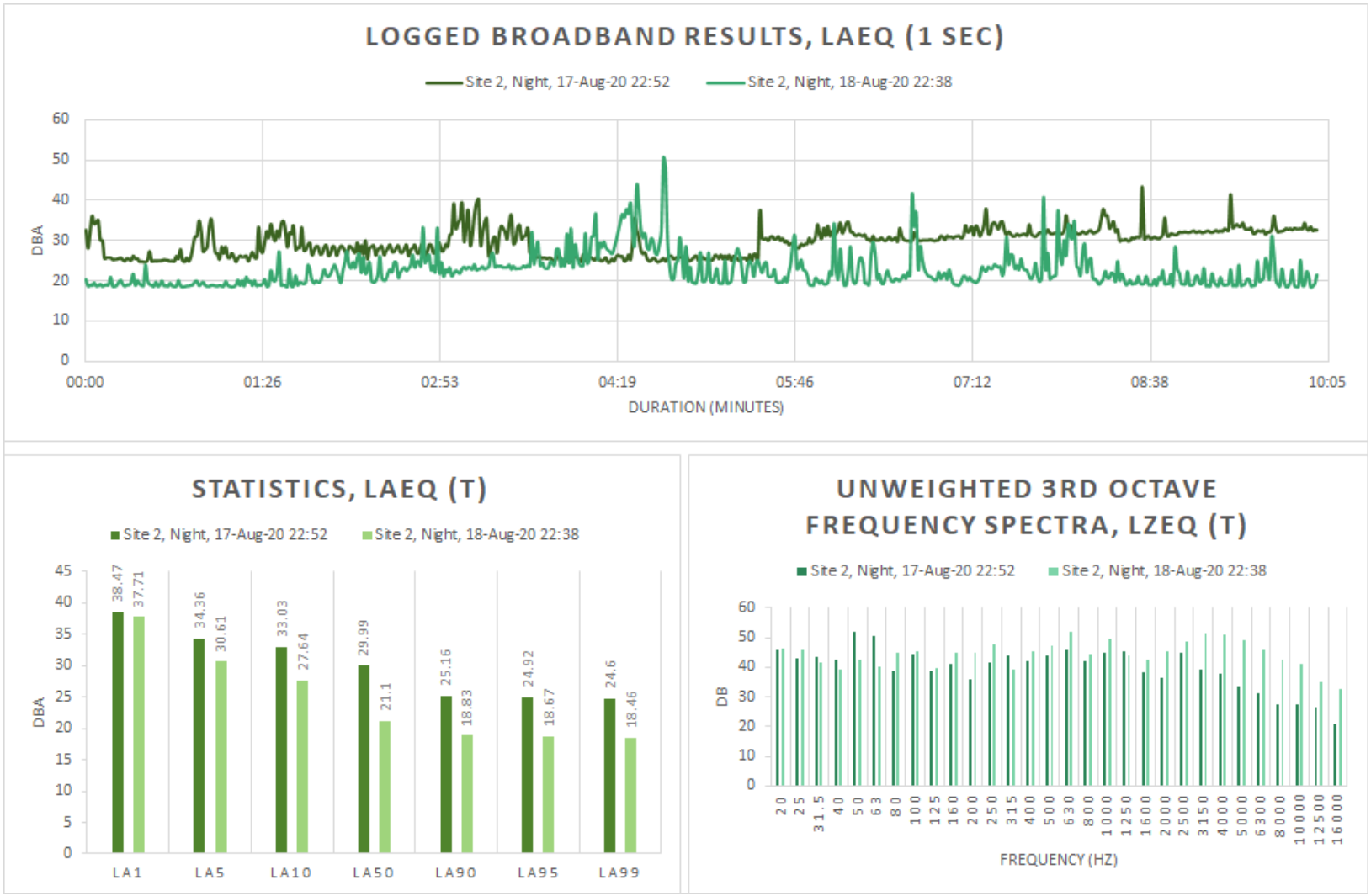

Figure 35: Detailed night -time survey results for Site 2

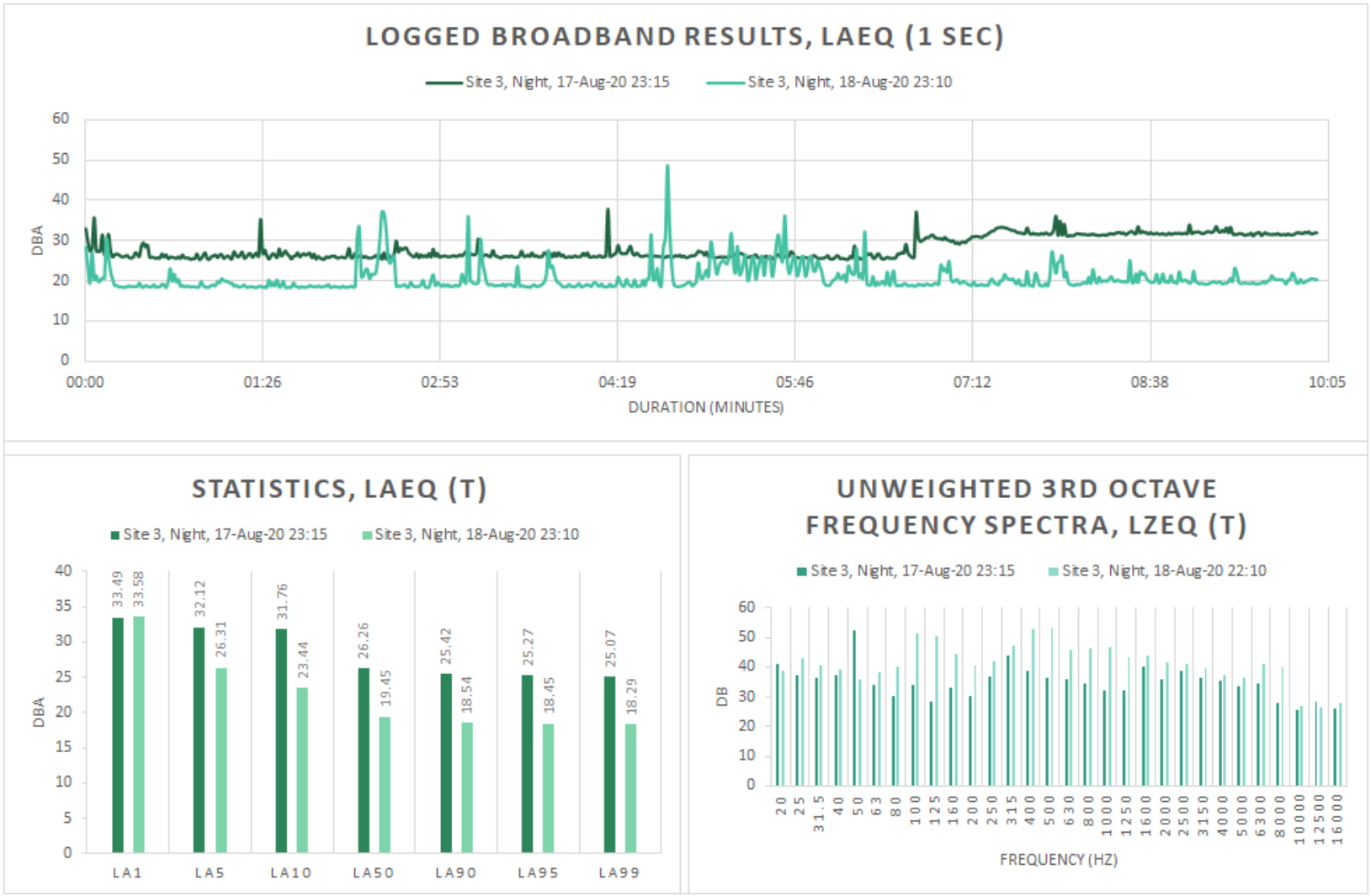

Figure 36: Detailed night -time survey results for Site 3

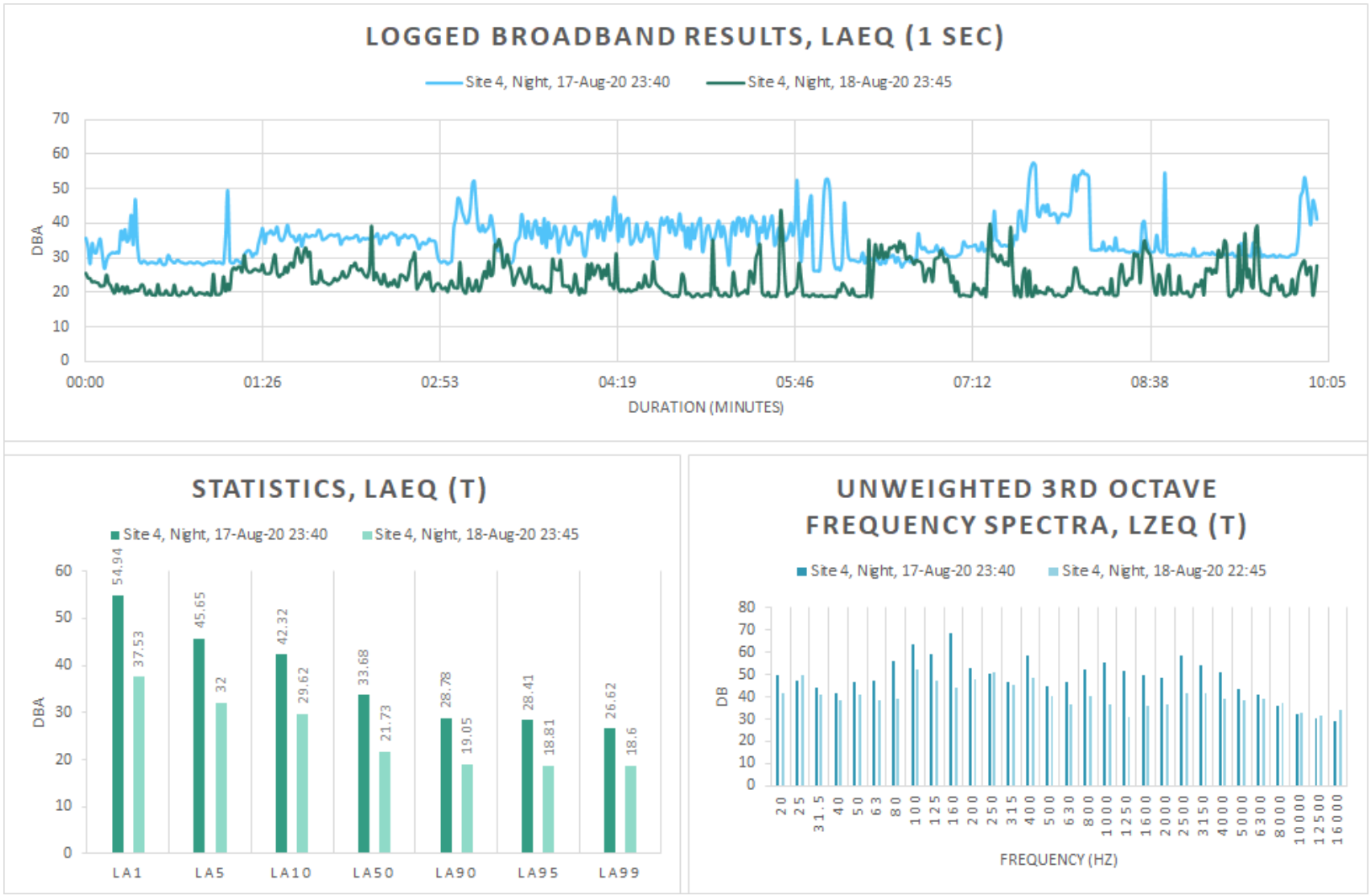

Figure 37: Detailed night -time survey results for Site 4

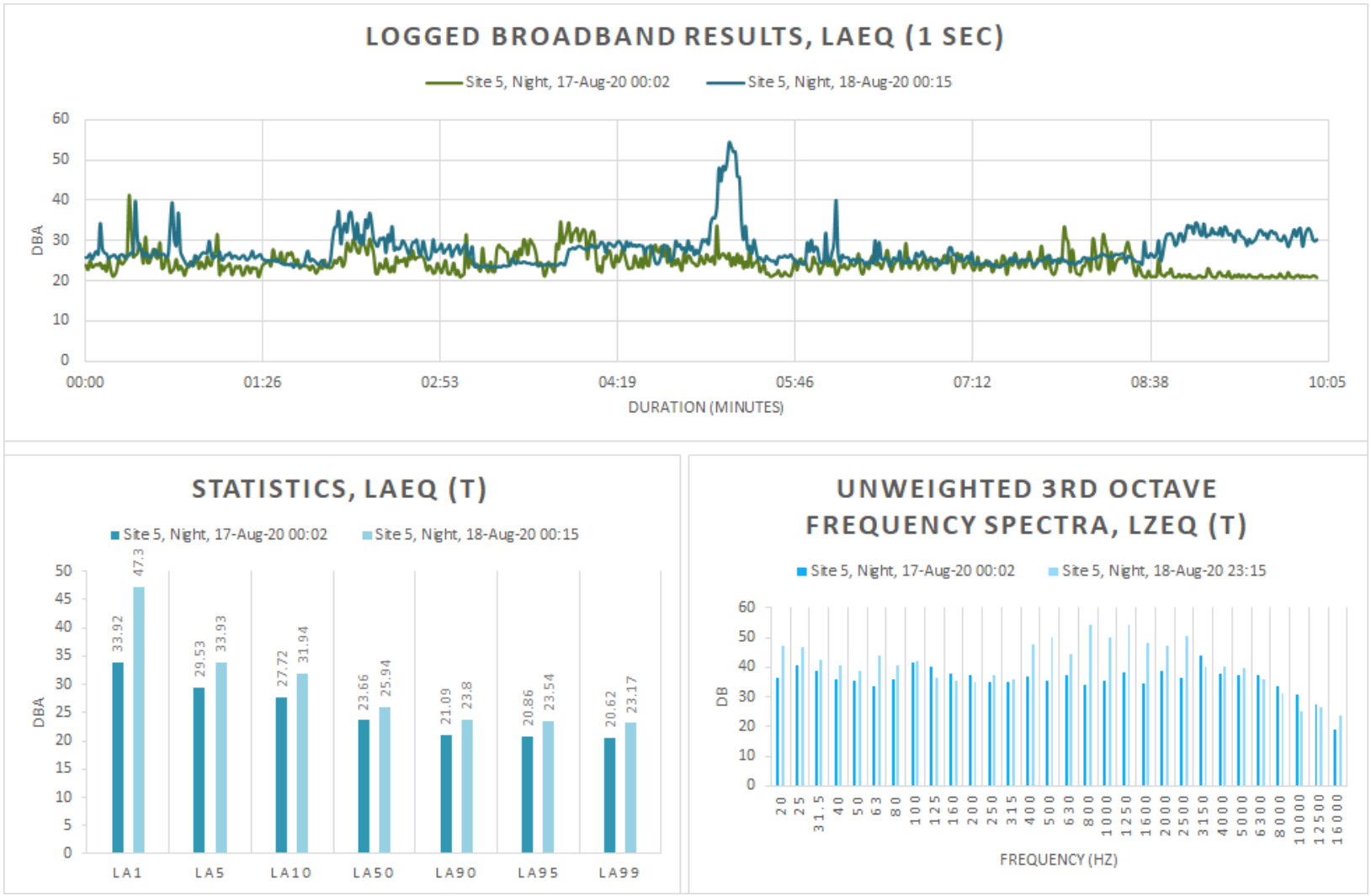

Figure 38: Detailed night -time survey results for Site 5

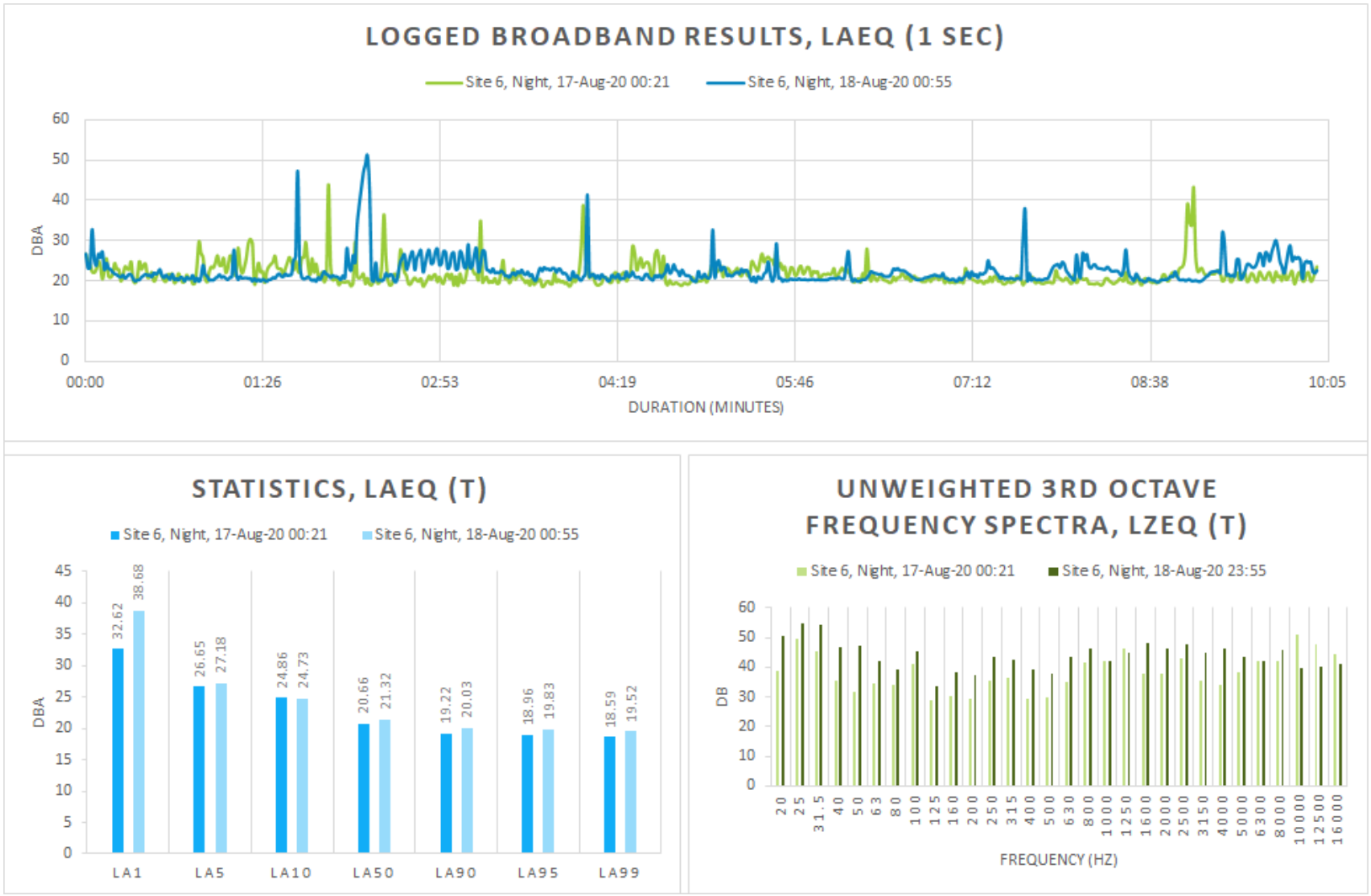

Figure 39: Detailed night -time survey results for Site 6

Appendix F – Impact Assessment Methodology

The methodology used for assessing the significance of the impact was obtained from the SLR.

PART A: DEFINITIONS AND CRITERIA		
Definition of SIGNIFICANCE		**Significance = consequence x probability**
Definition of CONSEQUENCE		**Consequence is a function of intensity, spatial extent and duration**
Criteria for ranking of the INTENSITY of environmental impacts	**VH**	Severe change, disturbance or degradation. Associated with severe consequences. May result in severe illness, injury or death. Targets, limits and thresholds of concern continually exceeded. Substantial intervention will be required. Vigorous/widespread community mobilization against project can be expected. May result in legal action if impact occurs.
	H	Prominent change, disturbance or degradation. Associated with real and substantial consequences. May result in illness or injury. Targets, limits and thresholds of concern regularly exceeded. Will definitely require intervention. Threats of community action. Regular complaints can be expected when the impact takes place.
	M	Moderate change, disturbance or discomfort. Associated with real but not substantial consequences. Targets, limits and thresholds of concern may occasionally be exceeded. Likely to require some intervention. Occasional complaints can be expected.
	L	Minor (Slight) change, disturbance or nuisance. Associated with minor consequences or deterioration. Targets, limits and thresholds of concern rarely exceeded. Require only minor interventions or clean-up actions. Sporadic complaints could be expected.
	VL	Negligible change, disturbance or nuisance. Associated with very minor consequences or deterioration. Targets, limits and thresholds of concern never exceeded. No interventions or clean-up actions required. No complaints anticipated.
	VL+	Negligible change or improvement. Almost no benefits. Change not measurable/will remain in the current range.
	L+	Minor change or improvement. Minor benefits. Change not measurable/will remain in the current range. Few people will experience benefits.
	M+	Moderate change or improvement. Real but not substantial benefits. Will be within or marginally better than the current conditions. Small number of people will experience benefits.
	H+	Prominent change or improvement. Real and substantial benefits. Will be better than current conditions. Many people will experience benefits. General community support.
	VH+	Substantial, large-scale change or improvement. Considerable and widespread benefit. Will be much better than the current conditions. Favourable publicity and/or widespread support expected.
Criteria for ranking the DURATION of impacts	**VL**	Very short, always less than a year. Quickly reversible
	L	Short-term, occurs for more than 1 but less than 5 years. Reversible over time.
	M	Medium-term, 5 to 10 years.
	H	Long term, between 10 and 20 years. (Likely to cease at the end of the operational life of the activity)
	VH	Very long, permanent, +20 years (Irreversible. Beyond closure)
Criteria for ranking the EXTENT of impacts	**VL**	A part of the site/property.
	L	Whole site.
	M	Beyond the site boundary, affecting immediate neighbours
	H	Local area, extending far beyond site boundary.
	VH	Regional/National

PART B: DETERMINING CONSEQUENCE							
			EXTENT				
			A part of the site/property	Whole site	Beyond the site, affecting neighbours	Local area, extending far beyond site.	Regional/ National
			VL	L	M	H	VH
INTENSITY = VL							
DURATION	Very long	VH	Low	Low	Medium	Medium	High
	Long term	H	Low	Low	Low	Medium	Medium
	Medium term	M	Very Low	Low	Low	Low	Medium
	Short term	L	Very low	Very Low	Low	Low	Low
	Very short	VL	Very low	Very Low	Very Low	Low	Low
INTENSITY = L							
DURATION	Very long	VH	Medium	Medium	Medium	High	High
	Long term	H	Low	Medium	Medium	Medium	High
	Medium term	M	Low	Low	Medium	Medium	Medium
	Short term	L	Low	Low	Low	Medium	Medium
	Very short	VL	Very low	Low	Low	Low	Medium
INTENSITY = M							
DURATION	Very long	VH	Medium	High	High	High	Very High
	Long term	H	Medium	Medium	Medium	High	High
	Medium term	M	Medium	Medium	Medium	High	High
	Short term	L	Low	Medium	Medium	Medium	High
	Very short	VL	Low	Low	Low	Medium	Medium
INTENSITY = H							
DURATION	Very long	VH	High	High	High	Very High	Very High
	Long term	H	Medium	High	High	High	Very High
	Medium term	M	Medium	Medium	High	High	High
	Short term	L	Medium	Medium	Medium	High	High
	Very short	VL	Low	Medium	Medium	Medium	High
INTENSITY = VH							
DURATION	Very long	VH	High	High	Very High	Very High	Very High
	Long term	H	High	High	High	Very High	Very High
	Medium term	M	Medium	High	High	High	Very High
	Short term	L	Medium	Medium	High	High	High
	Very short	VL	Low	Medium	Medium	High	High
			VL	L	M	H	VH
			A part of the site/property	Whole site	Beyond the site, affecting neighbours	Local area, extending far beyond site.	Regional/ National
			EXTENT				

PART C: DETERMINING SIGNIFICANCE							
PROBABILITY (of exposure to impacts)	Definite/ Continuous	**VH**	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	Probable	**H**	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	Possible/ frequent	**M**	**Very Low**	**Very Low**	**Low**	**Medium**	**High**
	Conceivable	**L**	**Insignificant**	**Very Low**	**Low**	**Medium**	**High**
	Unlikely/ improbable	**VL**	**Insignificant**	**Insignificant**	**Very Low**	**Low**	**Medium**
			VL	**L**	**M**	**H**	**VH**
			CONSEQUENCE				

PART D: INTERPRETATION OF SIGNIFICANCE	
Significance	**Decision guideline**
Very High	Potential fatal flaw unless mitigated to lower significance.
High	It must have an influence on the decision. Substantial mitigation will be required.
Medium	It should have an influence on the decision. Mitigation will be required.
Low	Unlikely that it will have a real influence on the decision. Limited mitigation is likely to be required.
Very Low	It will not have an influence on the decision. Does not require any mitigation
Insignificant	Inconsequential, not requiring any consideration.

***VH = very high, H = high, M= medium, L= low and VL= very low and + denotes a positive impact.**