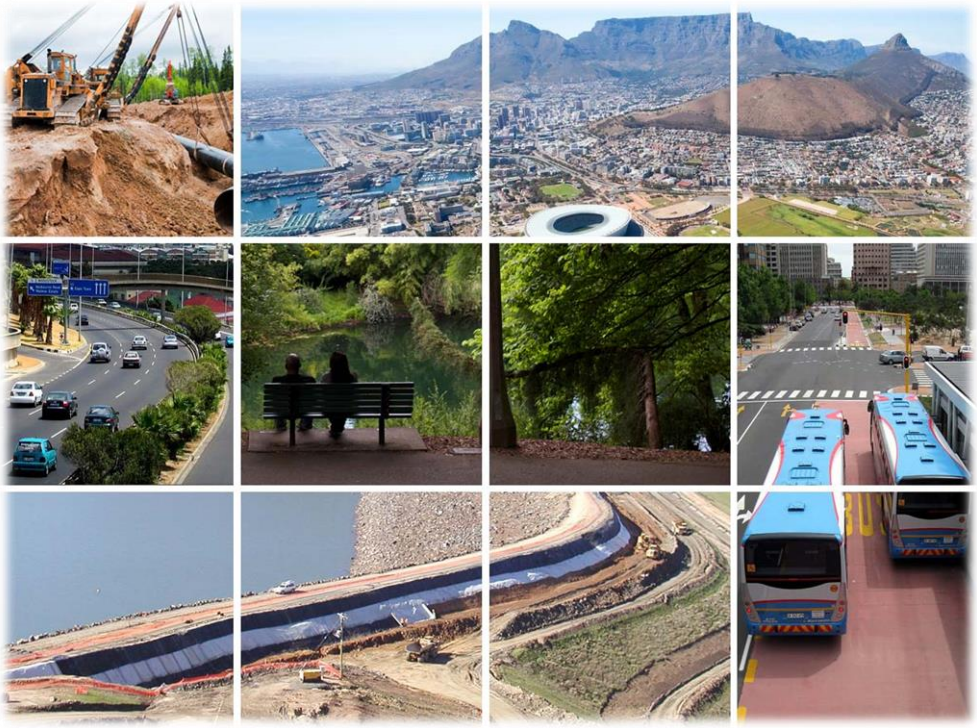
APPENDIX B2:

NOISE IMPACT ASSESSMENT

ENVIRONMENTAL NOISE IMPACT ASSESSMENT

for

uMkhomazi Water Project Phase 1, KwaZulu-Natal



Study done for:

NEMAI CONSULTING

Prepared by:

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EXECUTIVE SUMMARY

INTRODUCTION AND PURPOSE OF STUDY

Enviro-Acoustic Research (EARES) was contracted by Nemai Consulting, who is the Environmental Impact Assessment (EIA) Consultant for the uMkhomazi Water Project Phase 1 (uWMP-1), to determine the potential noise impact on the surrounding environment due to the proposed development of the uMWP-1.

This Report describes ambient sound levels in the area, potential worst-case noise rating levels and the potential noise impacts that the uMWP-1 project may have on the surrounding sound environment, highlighting the methods used, potential issues identified, findings and recommendations.

This Study considered local regulations and both local and international guidelines, using the Terms of Reference (ToR) as proposed by SANS 10328:2008 to allow for a comprehensive Environmental Noise Impact Assessment Report.

PROJECT DESCRIPTION

The Department of Water and Sanitation (DWS) and Umgeni Water (UW) are investigating the transfer of water from the undeveloped uMkhomazi River to the existing Integrated Mgeni Water Supply System (WSS). The Mkomazi-Mgeni Transfer Pre-feasibility Study concluded that the uMWP-1 would comprise a new dam at Smithfield on the uMkhomazi River near Richmond, a multi-level intake tower and pump station, a water transfer tunnel and pipeline, a balancing dam, a Water Treatment Works at Baynesfield in the uMlaza River Valley and a gravity pipeline to the Mgeni WSS, below the reservoir at Umlaas Road. From here, water will be distributed under gravity to eThekwini and possibly low-lying areas of Pietermaritzburg.

BASELINE ASSESSMENT

The existing soundscape was assessed by means of an audible judgement and sound measurements during a site visit in January 2018 that consisted of a number of 10 minute measurements.

The measurements indicated a complex sound environment, and while wind did influence the ambient sound levels at times, the site indicate the high potential to be quiet (locations away from houses and communities). Measurement locations close to the houses and communities indicated higher ambient sound levels, mainly due to typical noises associated with residential dwellings (voices, domestic animals, mechanical noise and other anthropogenic sounds).

NOISE IMPACT FINDINGS AND MITIGATION MEASURES

This Noise Impact Assessment used the noise emission characteristics of typical construction equipment that may be expected at such a project, taking a precautionary approach to considering the worst-case scenarios. This Study considers a scenario where development takes place at the locations proposed for infrastructure, quarries and borrow pits as well as where construction activities may take place. One of the proposed borrow pits are located close and within the potential identified habitat of the Blue Swallows.

Conceptual noise propagation models were developed for various scenarios as described in this Report. The resulting output of the model highlights a potential for a noise impact of medium significance due to construction activities of the tunnel adit as well as the western ventilation shaft.

While there is a risk of a noise impact this impact can be mitigated and reduced with the magnitude of the reduction depending on the options selected, as well as how the activities are managed. The proposed project (the uMWP-1) will not introduce potential fatal flaws in terms of acoustics. With the selection of the required mitigation options, anticipated noise levels can be managed.

NEED AND DESIRABILITY OF PROJECT – INCLUDING PROJECT ALTERNATIVES

The additional activities (worst-case evaluated) will raise the noise levels due to construction activities. The changes in ambient sound levels could be of medium significance at night and the closest receptors may find the noises disturbing and unacceptable. Management and mitigation are available to reduce the significance of the noise impact, but the construction activities will be audible and the closest receptors may still find it disturbing.

The construction activities will create employment and secondary business opportunities. The uMWP-1 project will generate a financial benefit on a regional to national scale by ensuring adequate water to the Pietermaritzburg area in the future.

RECOMMENDATIONS

It is recommended that:

- that the Contractor include an Environmental Awareness Component in their Safety and Health Induction, which should include a sound and noise facet to create awareness amongst all employees and sub-contractors in terms of the potential noise risks that activities (especially night-time activities) could pose to the surrounding environment;
- Convene meetings with the affected communities and other stakeholders to discuss the anticipated noise levels as well as to identify viable mitigation measures;
- Plan for the use the available to construct berms to assist serve as acoustical screens, where possible, between the construction activities and surrounding noise-sensitive receptors to break the line of sight as soon as possible. These berms should ideally be constructed during the daytime using minimal construction equipment. f these berms are correctly constructed, they can significantly reduce the noise impacts on the surrounding receptors;
- The use the smaller and less noisier equipment when operating near receptors;
- Where possible, that construction activities only take place during the daytime when work take place closer than 600 m from potential noise-sensitive receptors;
- During night-time construction activities, the operations should not be closer than 600 m from any receptors in order to prevent noise levels exceeding 45 dBA at the receptors. The specific use of acoustic screens (soil or spoil pile berms or even temporary screens) between receptors and construction activities (receptors closer than 600 m from the construction activities) are recommended to reduce noise levels.

- Ensure that no night-time construction activities take place closer than 1,500 m from any active Blue Swallow nesting sites. If acoustic screens are developed (constructed) between the Blue Swallow nesting sites and the construction activities, then the noise levels will be less, but if night-time activities are planned this must be confirmed with noise measurements or noise propagation modelling.
- Ensure that all equipment is well maintained and fitted with the correct and appropriate noise abatement measures.
- Transporting of equipment and material to take place during daytime periods where possible.

CONCLUSIONS

It is concluded that:

- There is a risk of medium significance noise impacts (tunnel adit and western ventilation shafts construction activities), which can be mitigated and reduced with the magnitude of the reduction depending on the selected options (technical and management options selected to manage noise levels) as well as the way in which construction and other activities are managed, and
- The uMWP-1 will not introduce any potential fatal flaws in terms of acoustics.
- With the selection of the required mitigation options, projected noise levels can be managed and Environmental Authorization can be granted.

CONTENTS OF THE SPECIALIST REPORT – CHECKLISTS

Contents of this Report in terms of Regulation GNR 982 of 2014, Appendix 6	**Cross-reference in this Report**
(a) details of— the specialist who prepared the report; and the expertise of that specialist to compile a specialist report including a curriculum vitae;	**Section 12**
(b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	**Section 13**
(c) an indication of the scope of, and the purpose for which, the report was prepared;	**Section 1.1**
(d) the date and season of the site investigation and the relevance of the season to the outcome of the assessment;	**Sections 3.1 & 3.3**
(e) a description of the methodology adopted in preparing the report or carrying out the specialised process;	**Section 1.5**
(f) the specific identified sensitivity of the site related to the activity and its associated structures and infrastructure;	**Section 3.3**
(g) an identification of any areas to be avoided, including buffers;	Not relevant and required. Noise contours modelled and illustrated in **Sections 7.1 & 7.3.**
(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;	
(i) a description of any assumptions made and any uncertainties or gaps in knowledge;	**Section 6**
(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;	**Sections 7** & **8**
(k) any mitigation measures for inclusion in the Environmental Management Programme (EMPr);.	**Sections 9.4.2**
(l) any conditions for inclusion in the Environmental Authorisation;	**Sections 9.4.1**
(m) any monitoring requirements for inclusion in the EMPr or Environmental Authorisation;	**Section 10**
(n) a reasoned opinion— i) as to whether the proposed activity or portions thereof should be authorised, and ii) 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 or Environmental Authorization, and where applicable, the closure plan;	i) **Section 11** ii) **Sections 9.1 & 9.2**
(o) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	No comments received
(p) any other information requested by the competent authority	Nothing requested

Contents of this Report in terms of Regulation GNR 982 of 2014, Appendix 3 - Environmental Impact Assessment Process	**Cross-reference in this Report**
Describe any policies or legislation relevant to your field that the applicant will need to comply with.	**Section 2**, specifically **2.2.1**
Comment on need/desirability of the proposal in terms your field and in terms of the proposal's location.	**Executive Summary**
Determine the-- (i) nature, significance, consequence, extent, duration and probability of the impacts occurring to inform identified preferred alternatives; and (ii) degree to which these impacts- (aa) can be reversed; (bb) may cause irreplaceable loss of resources, and (cc) can be avoided, managed or mitigated;	**Sections 8.1, 8.2 & 8.3**
Determine what the most ideal location within the site for the activity is in terms of your field.	**Not relevant, the location is determined by the location of the mineral resource**
Identify suitable measures to avoid, manage or mitigate identified impacts.	(i) **planning, design and pre-construction**; **Section 8.1** (iii) **construction**; **Section 8.1** (iv) **operation;** **Section 8.2** (v) **decommissioning, closure & rehabilitation**. **Section 8.3**
Identify residual risks that need to be managed and monitored.	There will be no residual risks after closure.
Include a concluding statement indicating a preferred alternative in terms of your field.	No alternative available.

This Report should be sited as:

De Jager, M. (2018): "*Environmental Noise Impact Assessment for uMkhomazi Water Project, KwaZulu-Natal*". Enviro-Acoustic Research CC, Pretoria

Client:

Nemai Consulting (Pty) Ltd
for Department of Water and Sanitation / Umgeni Water

Report No:

NEMAI-UWP/ENIA/201801-Rev 2

Author:

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Date:

May 2018

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GLOSSARY OF ABBREVIATIONS

ADT	Articulated Dump Trucks
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
DWA	Department of Water Affairs (now DWS)
DWAF	Department of Water Affairs and Forestry (now DWS)
DWS	Department of Water and Sanitation
EARES	Enviro Acoustic Research cc
ECA	Environment Conservation Act
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment
EHS	Environmental Health and Safety
ENIA	Environmental Noise Impact Assessment
ENM	Environmental Noise Monitoring
ENPAT	Environmental Potential Atlas for South Africa
EPs	Equator Principles
EPFIs	Equator Principles Financial Institutions
FEL	Front-end Loader
FSL	Full Supply Level
GN	Government Notice
IA	Implementing Agent
I&APs	Interested and Affected Parties
IDP	Integrated Development Plan
IEC	International Electrotechnical Commission
IFC	International Finance Corporation
ISO	International Organization for Standardization
KZN	KwaZulu-Natal
METI	Ministry of Economy, Trade, and Industry
NASA	National Aeronautical and Space Administration
NEMA	National Environmental Management Act
NCR	Noise Control Regulations
NSD	Noise-sensitive Development
O&M	Operation and Maintenance
PPP	Public Participation Process
PWL	Sound Power Level
RID	Record of Implementation Decisions
SABS	South African Bureau of Standards
SANS	South African National Standards
SPL	Sound Power Level
SR	Significance Rating
TBM	Tunnel Boring Machine
uMWP-1	uMkhomazi Water Project Phase 1
UTM	Universal Transverse Mercator
UW	Umgeni Water
WHO	World Health Organization
WSS	Water Supply System

WTW	Water Treatment Works
WULA	Water Use Licence Application

GLOSSARY OF UNITS

dB	Decibel (expression of the relative loudness of the un-weighted sound level in air)
dBA	Decibel (expression of the relative loudness of the A-weighted sound level in air)
Hz	Hertz (measurement of frequency)
kg/m^2	Surface density (measurement of surface density)
km	kilometre (measurement of distance)
m	Meter (measurement of distance)
m^2	Square meter (measurement of area)
m^3	Cubic meter (measurement of volume)
mamsl	Meters above mean sea level
m/s	Meter per second (measurement for velocity)
^oC	Degrees Celsius (measurement of temperature)
µPa	Micro pascal (measurement of pressure – in air in this document)

1 INTRODUCTION

1.1 INTRODUCTION AND PURPOSE

Enviro-Acoustic Research (EARES) was contracted by Nemai Consulting, who is the Environmental Impacts Assessment (EIA) Consultant for the uMkhomazi Water Project Phase 1 (uMWP-1), to determine the potential noise impact on the surrounding environment due to the proposed development of the uMWP-1. The regional locality of the uMWP-1 is indicated on **Figure 1-1** below.

This Study also considers a scenario where development takes place at the locations proposed for infrastructure, quarries and borrow pits as well as where construction activities may take place. One of the proposed borrow pits are located close and within the potential identified habitat of the Blue Swallows.

This Report describes ambient sound levels in the area, potential worst-case noise rating levels and the potential noise impacts that the uMWP-1 project may have on the surrounding sound environment, highlighting the methods used, potential issues identified, findings and recommendations. This Report also specifically investigates the potential noise impact on the Blue Swallows breeding areas in the vicinity of the construction sites.

This Study considered local regulations and both local and international guidelines, using the terms of reference as proposed by SANS 10328:2008 to allow for a comprehensive Environmental Noise Impact Assessment (ENIA).

1.2 BRIEF PROJECT DESCRIPTION

The Department of Water and Sanitation (DWS) and Umgeni Water (UW) are investigating the transfer of water from the undeveloped uMkhomazi River to the existing Integrated Mgeni Water Supply System (WSS). The Mkomazi-Mgeni Transfer Pre-feasibility Study concluded that the uMWP-1 would comprise a new dam at Smithfield on the uMkhomazi River near Richmond, a multi-level intake tower and pump station, a water transfer tunnel and pipeline, a balancing dam, a Water Treatment Works (WTW) at Baynesfield in the uMlaza River Valley and a gravity pipeline to the Mgeni WSS, below the reservoir at Umlaas Road. From here, water will be distributed under gravity to eThekwini and possibly low-lying areas of Pietermaritzburg.

Key, potential noise generating planned infrastructure includes the following:

- Development of temporary and permanent access roads;
- Equipment and material delivery;
- Development of construction facilities (housing, laydown areas, site offices, etc.);
- Development of quarries, borrow areas and spoil sites;
- The development of the Smithfield Dam, including:
    - Relocation of power line, construction of the dam (embankment, saddle dam and spillway) deviation of the R617, a hydropower plant and appurtenant works;

- Development of the raw water conveyance infrastructure, including:
  - Access box cuts/adits for the tunnel boring machine, ventilation shafts;
- Development of the balancing dam, including:
  - Dam embankment, spillway, a hydropower plant, other infrastructure.

1.3 STUDY AREA

The proposed project is located approximately 20 – 46 km south-west of Pietermaritzburg (see **Figure** 1-1 below), in KwaZulu-Natal (KZN). The study area is further described in terms of environmental components that may contribute or change the sound character in the area.

1.3.1 Topography

The Environmental Potential Atlas for South Africa (ENPAT)[1] (1998) describes the topography as *"Low mountains"* and "*undulating hills and lowlands"*. The start and end of the uMWP-1 is situated at approximately 900 meters above sea level (mamsl). The topography of the local area is complex and natural features may assist in the attenuation of construction noises.

1.3.2 Surrounding Land Use

The main land uses in the vicinity of the uMWP-1 are agriculture and forestry, though there are a number of small communities living in the area. Existing land use activities are not expected to change the ambient sound levels.

1.3.3 Roads

The most important road (in terms of calculable acoustics near a receptors dwelling) is the R617 as it carries a higher volume of traffic than the other roads in the area. There are a number of smaller roads in the area, mainly used by the local communities. These secondary roads generally do not carry sufficient traffic to warrant considering their contribution to the ambient soundscape (even though these roads to contribute to single events). Noises from traffic however will not be considered in this report as the R617 are generally too far from the potential construction areas.

1.3.4 Residential Areas

The community of Ezibonvini are located close to a site identified for a potential tunnel ventilation shaft.

1.3.5 Potential Sensitive Areas

It was reported that there are Blue Swallow breeding sites in the vicinity of the proposed construction sites. This species is classified as "Critically Endangered" due to destruction of its habitat at both its breeding and wintering sites.

[1] Van Riet, W. Claassen, P. van Rensburg, J. van Viegen & L. du Plessis, "*Environmental Potential Atlas for South Africa"*, Pretoria, 1998.

1.3.6 Other Industrial Activities

Apart from daytime forestry activities, there are little other industrial activities that would impact on ambient sound levels in the area.

1.3.7 Ground Conditions and Vegetation

The area falls within the Grassland biome, though the natural veld has been significantly impacted due to agricultural and forestry activities. The ground surface is sufficiently covered with vegetation to assume 50% hard ground conditions for modelling purposes. It should be noted that this factor is only relevant for air-borne waves being reflected from the ground surface with certain frequencies slightly absorbed by the vegetation.

1.3.8 Existing Ambient Sound Levels

Onsite measurements and the existing soundscape are discussed in more detail in **Section 3** below.

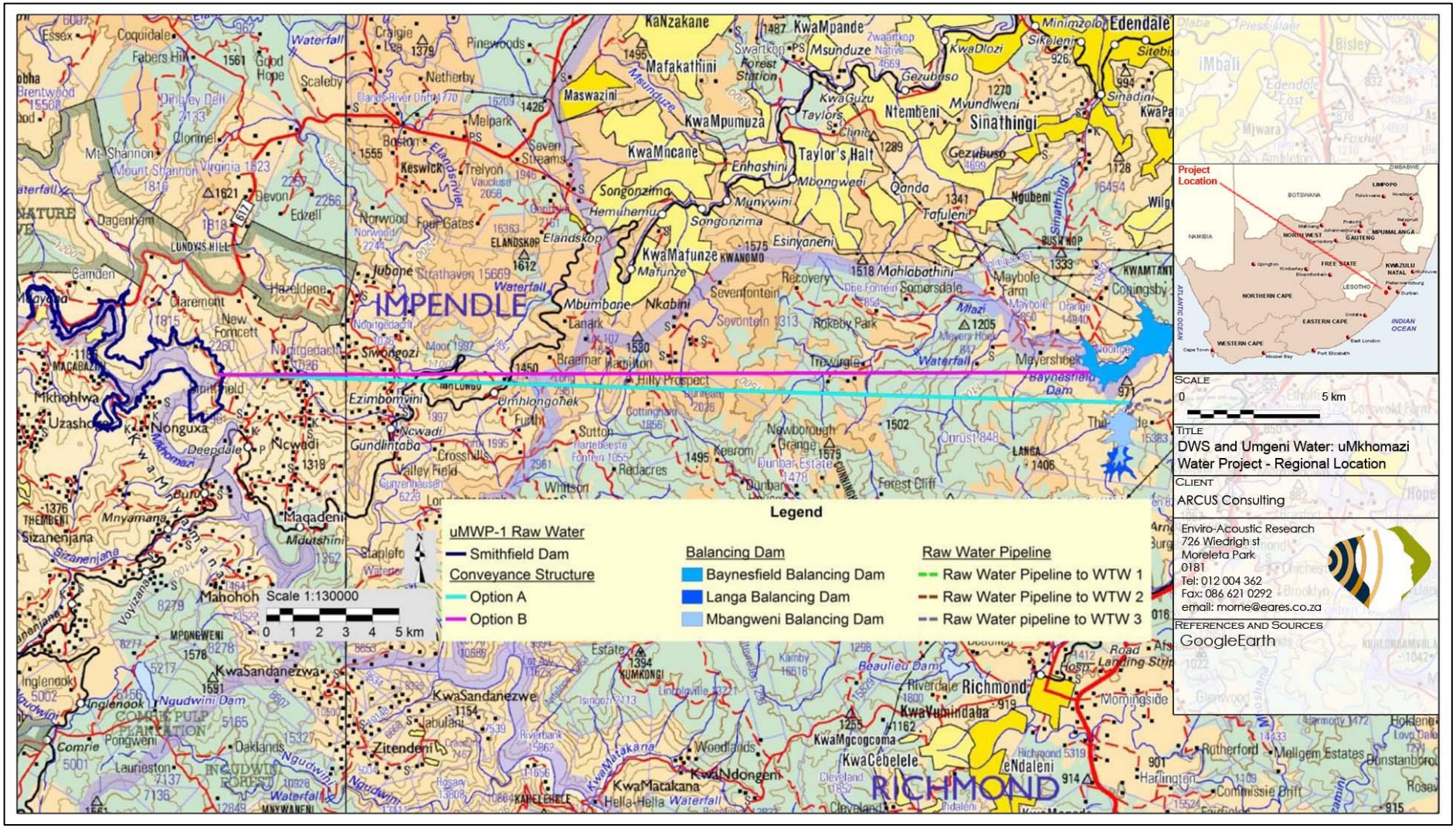

Figure 1-1: Site map indicating the Regional Locality of the uMWP-1

1.4 POTENTIAL NOISE-SENSITIVE RECEPTORS AND NO-GO AREAS

Potentially noise-sensitive receptors could be divided between human and faunal receptors, such as:

- Humans, mainly focussed at residential dwellings Noise-sensitive Developments (NSDs), especially at night when increased noises could impact on their quality of living. Residential dwellings were identified using Google Earth® followed by a site visit to confirm the status of the identified dwellings, as well as
- Faunal species, focussing especially on the Blue Swallow habitat and nesting sites in the area. Nesting sites and the potential habitat areas were identified and confirmed by an Avifauna Specialist (Allen, 2018).

These areas are indicated in **Figure 1-2** below. It should be noted that, if the uMWP-1 is implemented, some of the receptors must be relocated as they are below the proposed Smithfield Dam's Full Supply Level (FSL).

1.5 TERMS OF REFERENCE

A Noise Impact Assessment is required for the following reasons:

- If there are NSDs staying within 2 km from any wind turbine (SANS 10328:2008)
- It is a controlled activity in terms of the National Environmental Management Act (Act 107 of 1998) (NEMA) regulations and an ENIA is required, because:
    - It may cause a disturbing noise that is prohibited in terms of Section 18 (1) of Government Notice (GN) 579 of 2010, and
- It is generally required by the local or district authority as part of the Environmental Authorization or planning approval in terms of Regulation 2 (d) of GN R154 of 1992.

In addition, Appendix 6 of GN 326 of December 2014 (Government Gazette 38282), issued in terms of the NEMA (Act, No. 107 of 1998) also defines minimum information requirements for specialist reports.

The document that addresses the issues concerning environmental noise in South Africa is SANS 10103:2008, which was revised and brought in line with the guidelines of the World Health Organisation (WHO) during 2006 - 2008. It provides the maximum average ambient noise levels during the day and night to which different types of developments indoors may be exposed.

In addition, SANS 10328:2008 (Edition 2) specifies the methodology to assess the potential noise impacts on the environment due to a proposed activity that might impact on the environment. This standard also stipulates the minimum requirements to be investigated for scoping purposes. These minimum requirements are the following:

1. The purpose of the investigation;
2. A brief description of the planned development, or the changes that are being considered;
3. A brief description of the existing environment;

4. The identification of the noise sources that may affect the particular development, together with their respective estimated Sound Pressure Levels or sound power levels (or both);
5. The identified noise sources that were not taken into account and the reasons why they were not investigated;
6. The identified NSDs and the estimated impact on them;
7. Any assumptions made with regard to the estimated values used;
8. An explanation, either by a brief description or by reference, of the methods that were used to estimate the existing and predicted rating levels;
9. The location of the measurement or calculation points, i.e. a description, sketch or map;
10. Estimation of the environmental noise impact;
11. Alternatives that were considered and the results of those that were investigated;
12. A list of all the Interested and Affected Parties (I&APs) who submitted any comments with respect to the ENIA;
13. A detailed summary of all the comments received from I&APs as well as the procedures and discussions followed to deal with them;
14. Conclusions that were reached;
15. Recommendations, i.e. if there could be a significant impact, or if more information is needed, a recommendation that an ENIA be undertaken; and
16. If remedial measures will provide an acceptable solution, which would prevent a significant impact, these remedial measures should be outlined in detail and included in the final Record of Implementation Decisions (RID if the approval is obtained from the relevant authority. If the remedial measures deteriorate after a certain time and a follow-up auditing and/or Maintenance Programme are instituted, the Maintenance Programme should be included in the final recommendations and accepted in the RID, if the approval is obtained from the relevant authority.

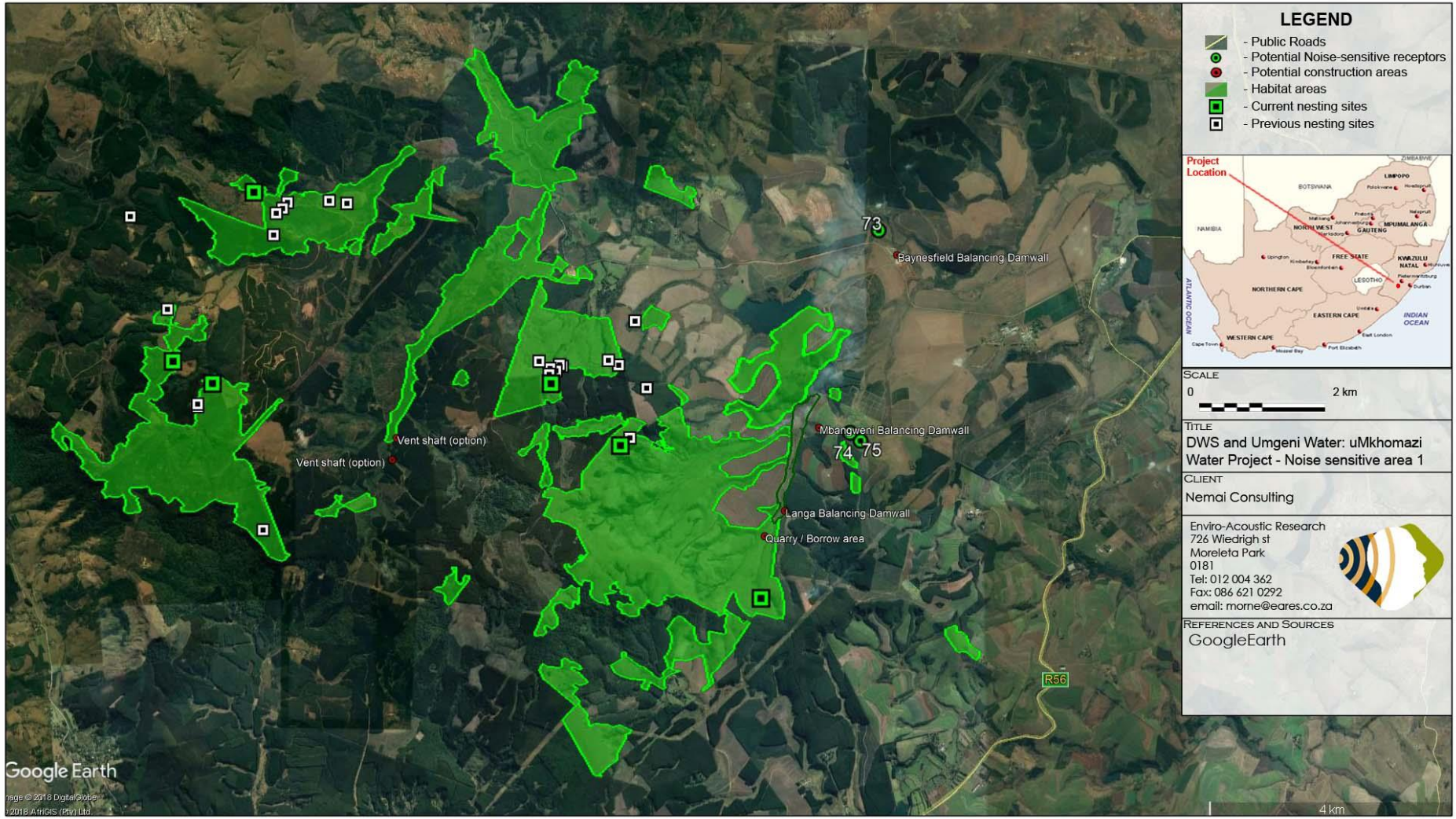

Figure 1-2: Aerial image indicating potentially noise-sensitive areas – close to the balancing dam and eastern ventilation shafts of the tunnel

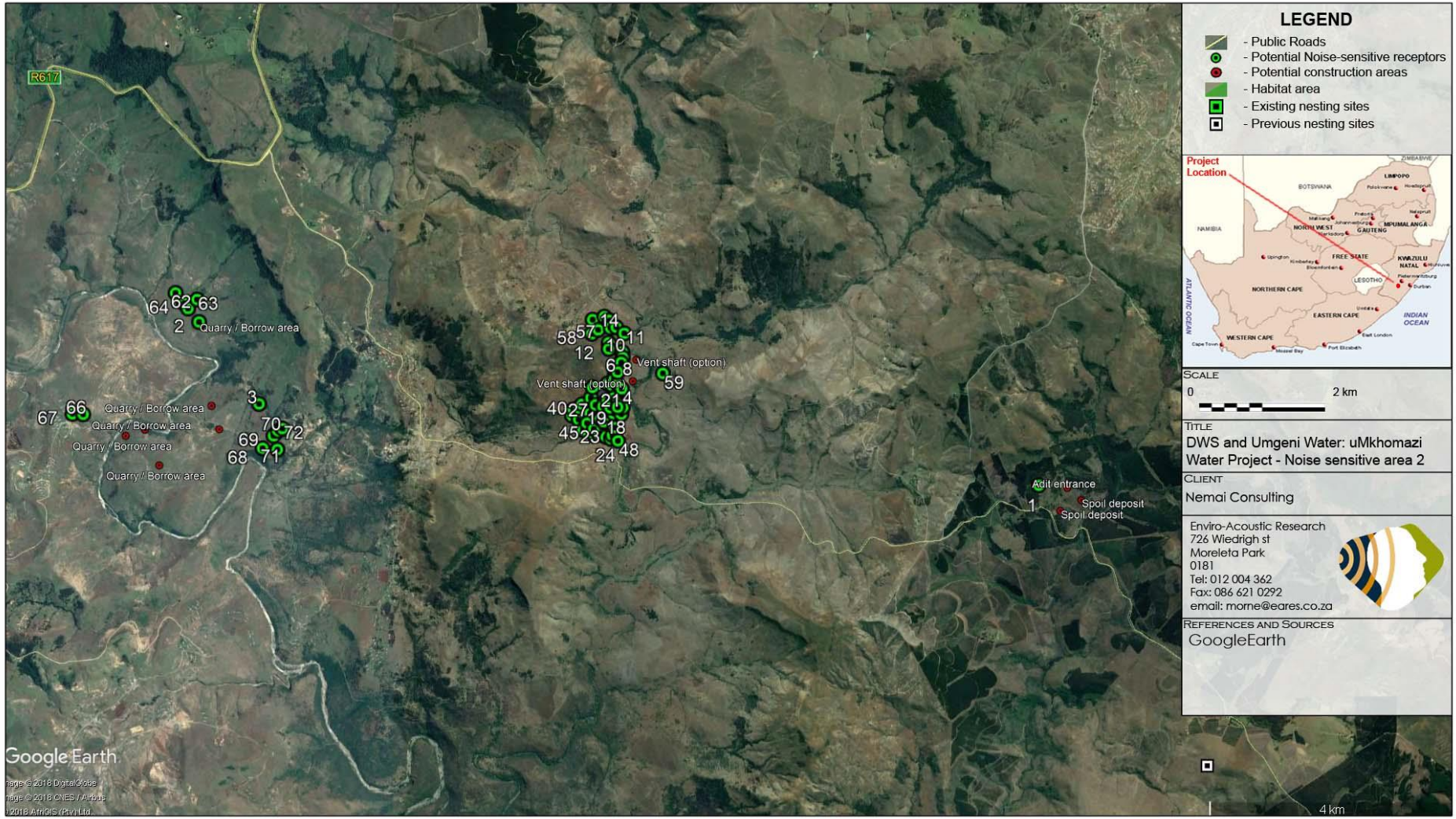

Figure 1-3: Aerial image indicating potentially noise-sensitive development – close to the varous construction activites

2 LEGAL CONTEXT, POLICIES AND GUIDELINES

2.1 THE REPUBLIC OF SOUTH AFRICA CONSTITUTION (THE CONSTITUTION)

The environmental rights contained in Section 24 of the Constitution (Act 108 of 1996) provide that everyone is entitled to an environment that is not harmful to his or her well-being. In the context of noise, this requires a determination of what level of noise is harmful to well-being. The general approach of the common law is to define an acceptable level of noise as that which the reasonable person can be expected to tolerate under the particular circumstances. The subjectivity of this approach can be problematic, which has led to the development of noise standards, which are outlined in **Sub Section 2.5** below.

"Noise pollution" is specifically included in Part B of Schedule 5 of the Constitution, which means that noise pollution control is a local authority competence, provided that the local authority concerned has the capacity to carry out this function.

2.2 THE ENVIRONMENT CONSERVATION ACT (ACT 73 OF 1989)

The Environment Conservation Act (ECA) allows the Minister of Environmental Affairs and Tourism ("now the Ministry of Water and Environmental Affairs") to make regulations regarding noise, among other concerns.

2.2.1 Noise Control Regulations (GN R154 of 1992)

In terms of Section 25 of the ECA, the National Noise Control Regulations (NCRs) (GN R154 in Government Gazette No. 13717 dated 10 January 1992) were promulgated. The NCRs were revised under Government Notice Number R. 55 of 14 January 1994 to make it obligatory for all authorities to apply the regulations.

Subsequently, in terms of Schedule 5 of the Constitution legislative responsibility for administering the noise control regulations was devolved to provincial and local authorities. Provincial Noise Control Regulations exist in the Free State, Gauteng and Western Cape provinces, but not in KZN.

The National Noise Control Regulations (GN R154 1992) define a:

"**controlled area**" as:

a piece of land designated by a local authority where, in the case of--

c) industrial noise in the vicinity of an industry-

i. the reading on an integrating impulse sound level meter, taken outdoors at the end of a period of 24 hours while such meter is in operation, exceeds 61 dBA, or

ii. the calculated outdoor equivalent continuous "A"-weighted sound pressure level at a height of at least 1,2 m, but not more than 1,4 m, above the ground for a period of 24 hours, exceeds 61 dBA;

"**disturbing noise**" as:

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.

"**zone sound level**" as:
a derived dBA value determined indirectly by means of a series of measurements, calculations or table readings and designated by a local authority for an area. *This is the same as the Rating Level as defined in SANS 10103.*

In addition:

In terms of Regulation 2 -
"A local authority may –
(c): if a noise emanating from a building, premises, vehicle, recreational vehicle or street is a disturbing noise or noise nuisance, or may in the opinion of the local authority concerned be a disturbing noise or noise nuisance, instruct in writing the person causing such noise or who is responsible therefor, or the owner or occupant of such building or premises from which or from where such noise emanates or may emanate, or all such persons, to discontinue or cause to be discontinued such noise, or to take steps to lower the level of the noise to a level conforming to the requirements of these Regulations within the period stipulated in the instruction: Provided that the provisions of this paragraph shall not apply in respect of a disturbing noise or noise nuisance caused by rail vehicles or aircraft which are not used as recreational vehicles;
(d): before changes are made to existing facilities or existing uses of land or buildings, or before new buildings are erected, in writing require that noise impact assessments or tests are conducted to the satisfaction of that local authority by the owner, developer, tenant or occupant of the facilities, land or buildings or that, for the purposes of regulation 3(b) or (c), reports or certificates in relation to the noise impact to the satisfaction of that local authority are submitted by the owner, developer, tenant or occupant to the local authority on written demand";

In terms of Regulation 4 of the NCRs:
"No person shall make, produce or cause a disturbing noise, or allow it to be made, produced or caused by any person, machine, device or apparatus or any combination thereof".

2.3 THE NATIONAL ENVIRONMENTAL MANAGEMENT ACT (ACT 107 OF 1998)

The NEMA defines "pollution" to include any change in the environment, including noise. A duty therefore arises under Section 28 of the NEMA to take reasonable measures while establishing and operating any facility to prevent noise pollution occurring. The NEMA sets out the following measures, which may be regarded as reasonable, to:

1. investigate, assess and evaluate the impact on the environment;
2. inform and educate employees about the environmental risks of their work and the manner in which their tasks must be performed in order to avoid causing significant pollution or degradation of the environment;
3. cease, modify or control any act, activity or process causing the pollution or degradation;
4. contain or prevent the movement of the pollution or degradation;
5. eliminate any source of the pollution or degradation, and
6. remedy the effects of the pollution or degradation.

2.4 NATIONAL ENVIRONMENTAL MANAGEMENT: AIR QUALITY ACT (ACT 39 OF 2004)

Section 34 of the National Environmental Management: Air Quality Act (Act 39 o f2004) makes provision for:

(1) the Minister to prescribe essential national noise standards -

(a) for the control of noise, either in general or by specified machinery or activities or in specified places or areas; or

(b) for determining –

(i) a definition of noise

(ii) the maximum levels of noise

(2) When controlling noise the provincial and local spheres of government are bound by any prescribed national standards.

Section 34 of the Act has been promulgated, but no such standards have yet been issued. Draft regulations have, however, been promulgated for adoption by local authorities.

An atmospheric emission licence issued in terms of Section 22 may contain conditions in terms of noise. This, however, is unlikely to be relevant to the uMWP-1 as no atmospheric emissions are expected to take place.

2.4.1 Model Air Quality Management By-law for Adoption and Adaptation by Municipalities (GN 579 of 2010)

Model Air Quality Management By-Law for adoption and adaptation by municipalities were published by the Department of Water and Environmental Affairs in Government Notice 579 of 2010 (2 July 2010).

The main aim of the Model Air Quality Management By-law is to assist municipalities in the development of their air quality management by-law within their jurisdictions. It is also the aim of this by-law to ensure uniformity across the country when dealing with air quality management challenges. Therefore, Model Air Quality Management By-law is developed to be generic in order to deal with most of the air quality management challenges. With noise control being covered under the Air Quality Act (Act 39 of 2004), noise is also managed in a separate section under this Government Notice.

- **IT IS NOT** the aim of this model by-law to have legal force and effect on municipalities when published in the Gazette; and
- **IT IS NOT** the aim of this model by-law to impose the by-law on municipalities.

Therefore, a municipality will have to follow the legal process as set out in the Local Government: Municipal Systems Act, 2000 (Act No. 32 of 2000) when adopting and adapting the Model Air Quality Management By-law to its area of jurisdiction.

2.5 NOISE STANDARDS

The following South African National Standards (SANS) are applicable to noise from mines, industry and roads:

- SANS 10103:2008. 'The measurement and rating of environmental noise with respect to annoyance and to speech communication';
- SANS 10210:2004. 'Calculating and predicting road traffic noise';
- SANS 10328:2008. 'Methods for environmental noise impact assessments'.
- SANS 10357:2004. 'The calculation of sound propagation by the Concave method';
- SANS 10181:2003. 'The Measurement of Noise Emitted by Road Vehicles when Stationary', and
- SANS 10205:2003. 'The Measurement of Noise Emitted by Motor Vehicles in Motion'.

The relevant standards use the equivalent continuous rating level as a basis for determining what is acceptable. The levels may take single event noise into account, but single event noise by itself does not determine whether noise levels are acceptable for land use purposes. With regards to SANS 10103:2008, the recommendations are likely to inform decisions by authorities, but non-compliance with the standard will not necessarily render an activity unlawful *per se.*

2.6 INTERNATIONAL GUIDELINES

While a number of international guidelines and standards exist, those that are discussed under **2.7.1** to **2.7.4** below are used by numerous countries for environmental noise management. These guidelines, however, mainly focus on human impact, with no guidelines available recommending acceptable or permissible noise levels on animals (including birds).

2.6.1 Guidelines for Community Noise (WHO, 1999)

The World Health Organization's (WHO) Document on the *Guidelines for Community Noise* is the outcome of the WHO expert task force meeting held in London, United Kingdom, in April 1999. It is based on the document entitled "Community Noise" that was prepared for the WHO and published in 1995 by the Stockholm University and Karolinska Institute.

The scope of WHO's effort to derive guidelines for community noise is to consolidate actual scientific knowledge on the health impacts of community noise and to provide guidance to environmental health authorities and professionals trying to protect people from the harmful effects of noise in non-industrial environments.

Guidance on the health effects of noise exposure of the population has already been given in an early publication of the series of Environmental Health Criteria. The health risk to humans from exposure to environmental noise was evaluated and guidelines values derived. The issue of noise control and health protection was briefly addressed.

The document uses the L_{Aeq} and $L_{A,max}$ noise descriptors to define noise levels. It should be noted that a follow-up document focusing on Night-time Noise Guidelines for Europe (WHO, 2009) was completed and discussed in **2.6.2** below.

2.6.2 Night Noise Guidelines for Europe (WHO, 2009)

Refining previous Community Noise Guidelines issued in 1999, and incorporating more recent research, the WHO has released a comprehensive report on the health effects of night time noise, along with new (non-mandatory) guidelines for use in Europe. Rather than a maximum of 30 dB inside at night (which equals 45-50 dB max outside), the WHO now recommends a maximum year-round outside night-time noise average of 40 dB to avoid sleep disturbance and its related health effects. The report notes that only at sound levels below 30 dB (outside annual average) "*no significant biological effects are observed*," and that between 30 and 40 dB, several effects are observed, with the chronically ill and children being more susceptible; however, "*even in the worst cases the effects seem modest*." Elsewhere, the report states more definitively, "*There is no sufficient evidence that the biological effects observed at the level below 40 dB (night, outside) are harmful to health*." At levels over 40 dB, "*Adverse health effects are observed*" and "*many people have to adapt their lives to cope with the noise at night. Vulnerable groups are more severely affected*."

The 184-page report offers a comprehensive overview of research into the various effects of noise on sleep quality and health (including the health effects of non-waking sleep arousal), and is recommended reading for anyone working with noise issues. The use of an outdoor noise standard is in part designed to acknowledge that people do prefer to leave windows open when sleeping, though the year-long average may be difficult to obtain (it would require longer-term sound monitoring than is usually budgeted for by either industry or neighbourhood groups).

While recommending the use of the average level, the report notes that some instantaneous effects occur in relation to specific maximum noise levels, but that the health effects of these "cannot be easily established."

2.6.3 Equator Principles

The Equator Principles (EPs) are a voluntary set of standards for determining, assessing and managing social and environmental risk in project financing. Equator Principles Financial Institutions (EPFIs) commit to not providing loans to projects where the borrower will not or is unable to comply with their respective social and environmental policies and procedures that implement the EPs.

The EPs were developed by private sector banks and were launched in June 2003. The banks chose to model the EPs on the environmental standards of the World Bank and the social policies of the International Finance Corporation (IFC). Sixty seven (67) financial institutions (October 2009) have adopted the EPs, which have become the de facto standard for banks and investors on how to assess major development projects around the world. The environmental standards of the World Bank have been integrated into the social policies of the IFC since April 2007 as the IFC Environmental, Health and Safety (EHS) Guidelines.

2.6.4 IFC: General EHS Guidelines – Environmental Noise Management

These guidelines are applicable to noise created beyond the property boundaries of a development that conforms to the EPs.

It states that noise prevention and mitigation measures should be applied where predicted or measured noise impacts from a project facility or operations exceed the applicable noise level guideline at the most sensitive point of reception. The preferred method for controlling noise from stationary sources is to implement noise control measures at source.

It goes as far as to propose methods for the prevention and control of noise emissions, including:

- Selecting equipment with lower sound power levels;
- Installing silencers for fans;
- Installing suitable mufflers on engine exhausts and compressor components;
- Installing acoustic enclosures for equipment casing radiating noise;
- Improving the acoustic performance of constructed buildings, apply sound insulation;
- Installing acoustic barriers without gaps and with a continuous minimum surface density of 10 kg/m^2 in order to minimize the transmission of sound through the barrier. Barriers should be located as close to the source or to the receptor location to be effective;
- Installing vibration isolation for mechanical equipment;
- Limiting the hours of operation for specific pieces of equipment or operations, especially mobile sources operating through community areas ;
- Re-locating noise sources to less sensitive areas to take advantage of distance and shielding;
- Placement of permanent facilities away from community areas if possible;
- Taking advantage of the natural topography as a noise buffer during facility design;
- Reducing project traffic routing through community areas wherever possible;
- Planning flight routes, timing and altitude for aircraft (airplane and helicopter) flying over community areas; and
- Developing a mechanism to record and respond to complaints.

It sets noise level guidelines, as given in **Table 2-1** below, as well as highlighting the certain monitoring requirements pre- and post-development. It adds another criterion in that the existing background ambient noise level should not rise by more than 3 dBA. This criterion will effectively sterilize large areas of any development. It is, therefore, the considered opinion that this criterion was introduced to address cases where the existing ambient noise level is already at, or in excess of the recommended limits.

Table 2-1: Noise Level Guidelines (IFC Table .7.1)

Receptor Type	One Hour L_{Aeq} (dBA)	
	Daytime 07:00 - 22:00	**Night-time 22:00 – 07:00**
Residential; institutional and educational	55	45
Industrial and commercial	70	70

The document uses the $_{LAeq,1\ hr}$ noise descriptors to define noise levels. It does not determine the detection period, but refers to the International Electrotechnical Commission (IEC) Standards, which requires the fast detector setting on the Sound Level Meter during measurements for Europe.

3 CURRENT ENVIRONMENTAL SOUND CHARACTER IN THE AREA

3.1 EFFECT OF SEASON ON SOUND LEVELS

Natural sounds are a part of the environmental noise surrounding humans. In rural areas the sounds from insects and birds would dominate the ambient sound character, with noises such as wind flowing through vegetation increasing as wind speed increase. Work by Fégeant (2002) stressed the importance of wind speed and turbulence causing variations in the level of vegetation generated noise. In addition, factors such as the season (e.g. dry or no leaves versus green leaves), the type of vegetation (e.g. grass, conifers, deciduous), the vegetation density and the total vegetation surface all determine both the sound level as well as spectral characteristics.

Ambient sound levels are significantly affected by the area where the sound measurement location is situated. When the sound measurement location is situated within an urban area, close to industrial plants or areas with a constant sound source (ocean, rivers, etc.), seasons and even increased wind speeds have an insignificant to massive impact on ambient sound levels.

Sound levels in undeveloped rural areas (away from occupied dwellings), however, are impacted by changes in season for a number of complex reasons. The two main reasons are:

- Faunal communication during the warmer spring and summer months as various species communicate in an effort to find mates, and
- Seasonal changes in weather patterns, mainly wind (also see **Sub Section 3.2** below).

For environmental noise weather plays an important role, the greater the separation distance, the greater the influence of the weather conditions, so, from day to day, a road 1,000 m away can sound very loud or can be completely inaudible. Other, environmental factors that impact on sound propagation includes wind, temperature and humidity, as discussed in **3.1.1** to **3.1.3** below.

3.1.1 Effect of Wind

Wind alters sound propagation by the mechanism of refraction, that is, wind bends sound waves. Wind nearer to the ground moves more slowly than wind at higher altitudes, due to surface characteristics such as hills, trees, and man-made structures that interfere with the wind. This wind gradient, with faster wind at higher elevation and slower wind at lower elevation, causes sound waves to bend downward when they are traveling to a location downwind of the source and to bend upward when traveling toward a location upwind of the source. Waves bending downward means that a listener standing downwind of the source will hear louder noise levels than the listener standing upwind of the source. This phenomenon can significantly impact sound propagation over long distances and when wind speeds are high. Over short distances wind direction has a small impact on sound propagation as long as wind velocities are reasonably slow, i.e. less than 5 m/s.

3.1.2 Effect of Temperature

On a typical sunny afternoon the air is the hottest near the ground surface and temperature decreases at higher altitudes. This temperature gradient causes sound waves to refract upward, away from the

ground and results in lower noise levels being heard at a measurement location. In the evening, this temperature gradient will reverse, resulting in cooler temperatures near the ground. This condition, often referred to is a temperature inversion will cause sound to bend downward towards the ground and results in louder noise levels at the listener position. Like wind gradients, temperature gradients can influence sound propagation over long distances and further complicate measurements. Generally sound propagate better at lower temperatures (down to 10^{o}C), and with everything being equal, a decrease in temperature from 32^{o}C to 10^{o}C could decrease the sound level at a listener 600 m away by 3 dB (at 1,000 Hz).

3.1.3 Effect of Humidity

The effect of humidity on sound propagation is quite complex, but effectively relates how increased humidity changes the density of air. Lower density translates into faster sound wave travel, so sound waves travel faster at high humidity. With everything being equal, an increase in humidity from 20% to 80% would increase the sound level at a listener 600 m away by 3 dB (at 1,000 Hz at 20^{o}C).

3.2 Effect of Wind Speed on Vegetation and Sound Levels

Wind speed is a determining factor for sound levels at most rural locations. With no wind, there is little vegetation movement that could generate noises, however, as wind speeds increase, the rustling of leaves increases which subsequently can increase sound levels. This directly depends on the type of vegetation in a certain area. The impact of increased wind speed on sound levels depends on the vegetation type (deciduous versus connivers), the density of vegetation in an area, seasonal changes (in winter deciduous trees are bare) as well as the height of this vegetation. This excludes the effect of faunal communication as vegetation may create suitable habitats and food sources.

3.3 Ambient Sound Level and Character Measurements

Ambient (background) noise levels in the area were measured during January 2018 at a number of locations in accordance with SANS 10103:2008, which specifies the acceptable techniques for sound measurements including:

- type of equipment (Type 1 instrument, a calibrated Rion NA-28 was used);
- minimum duration of measurement;
- microphone positions;
- calibration procedures and instrument checks, and
- weather conditions.

The sound measurement locations are illustrated in **Figures 3-1** to **3-2** below as blue squares.

3.3.1 Summary of Ambient Sound Measurements

Photos of the measurement locations are presented in **Appendix B**. Sound levels measures and sounds heard onsite are summarised in **Table 3-1** below. All the measurements indicated a site with a very complex sound character. Areas away from roads and the communities are very quiet, though wind-induced noises did influence the measurements significantly as the wind speeds increased.

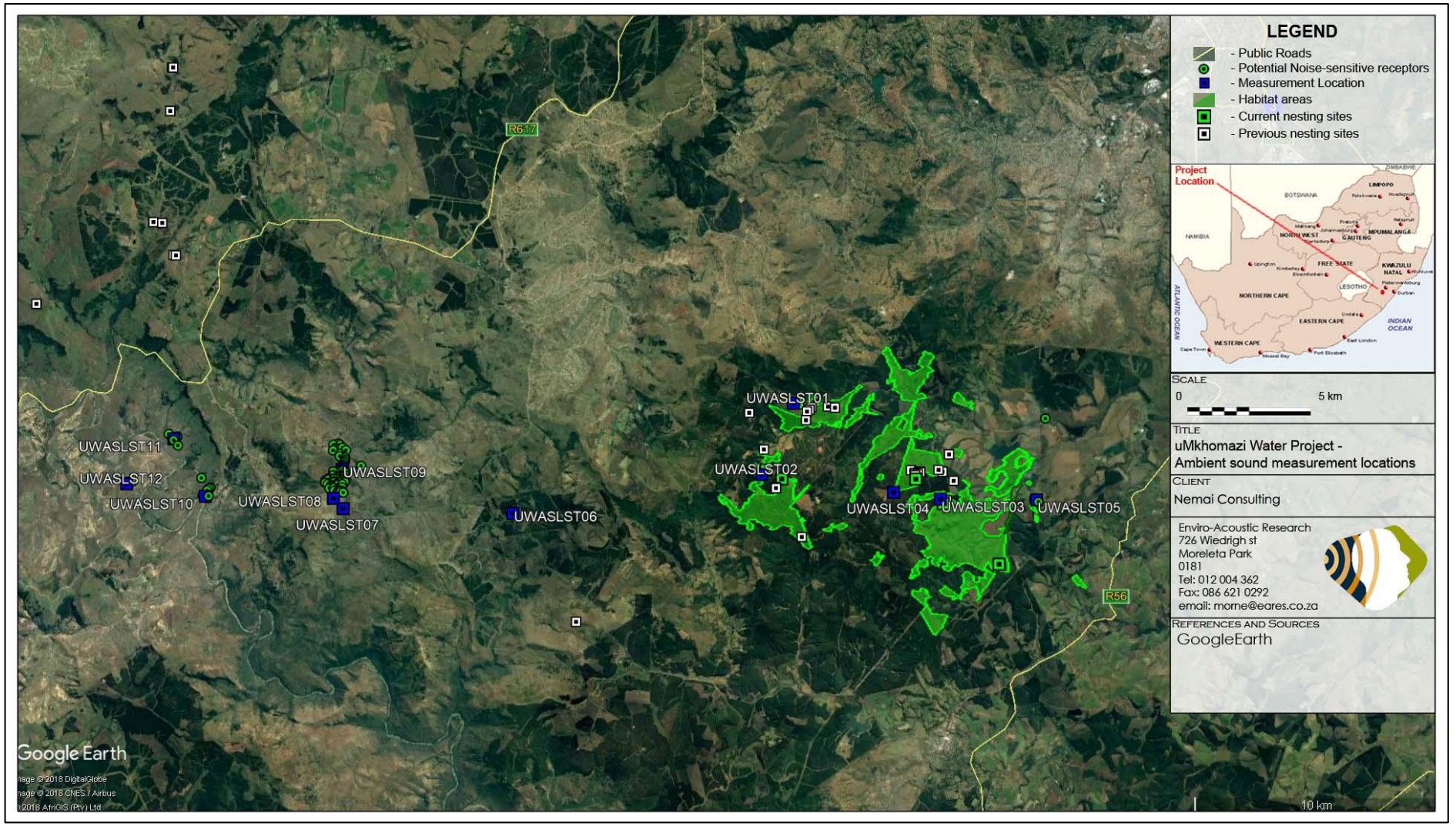

Figure 3-1: Localities where ambient sound levels were measured - Overview

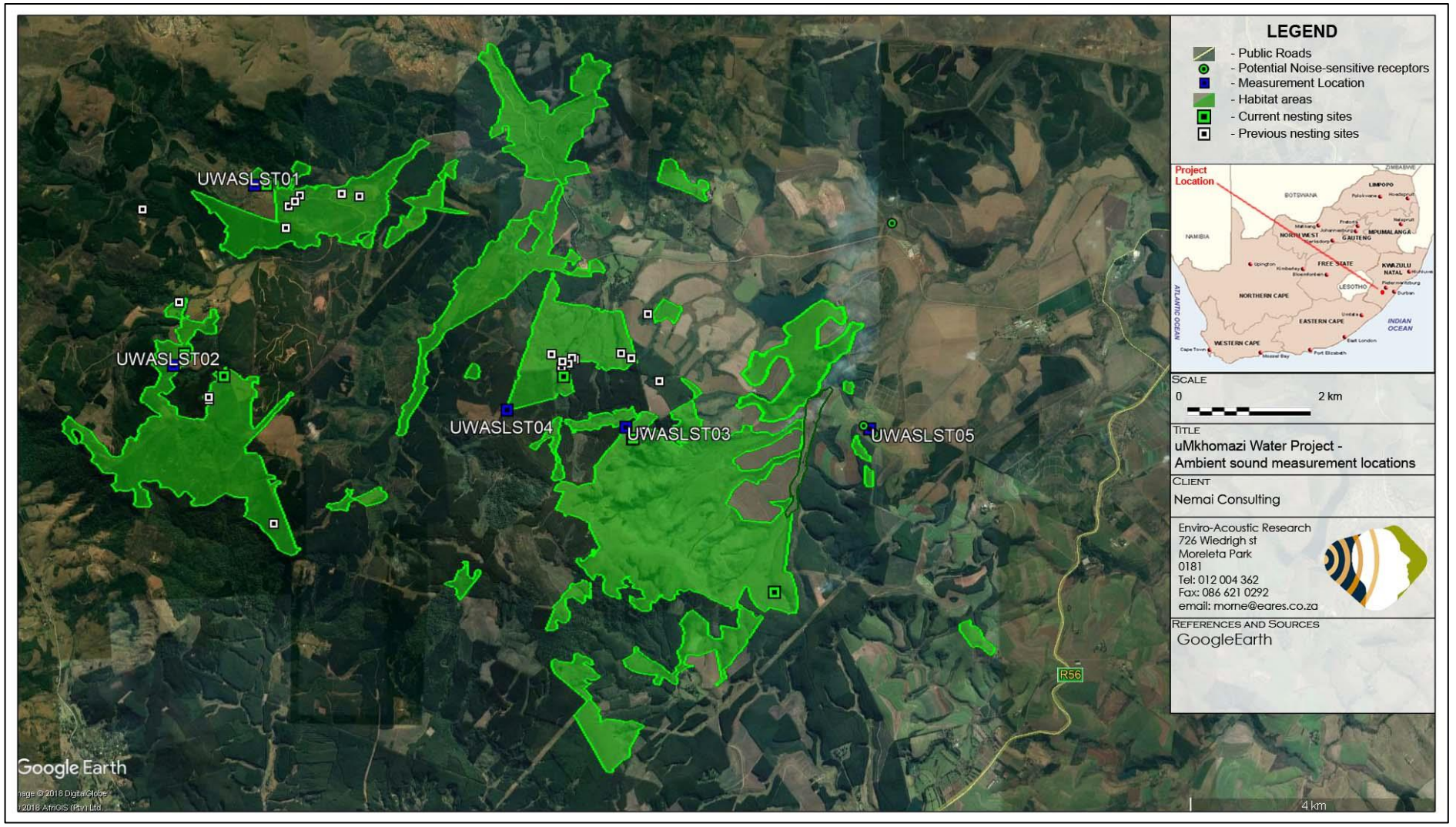

Figure 3-2: Localities where ambient sound levels were measured – Eastern Area

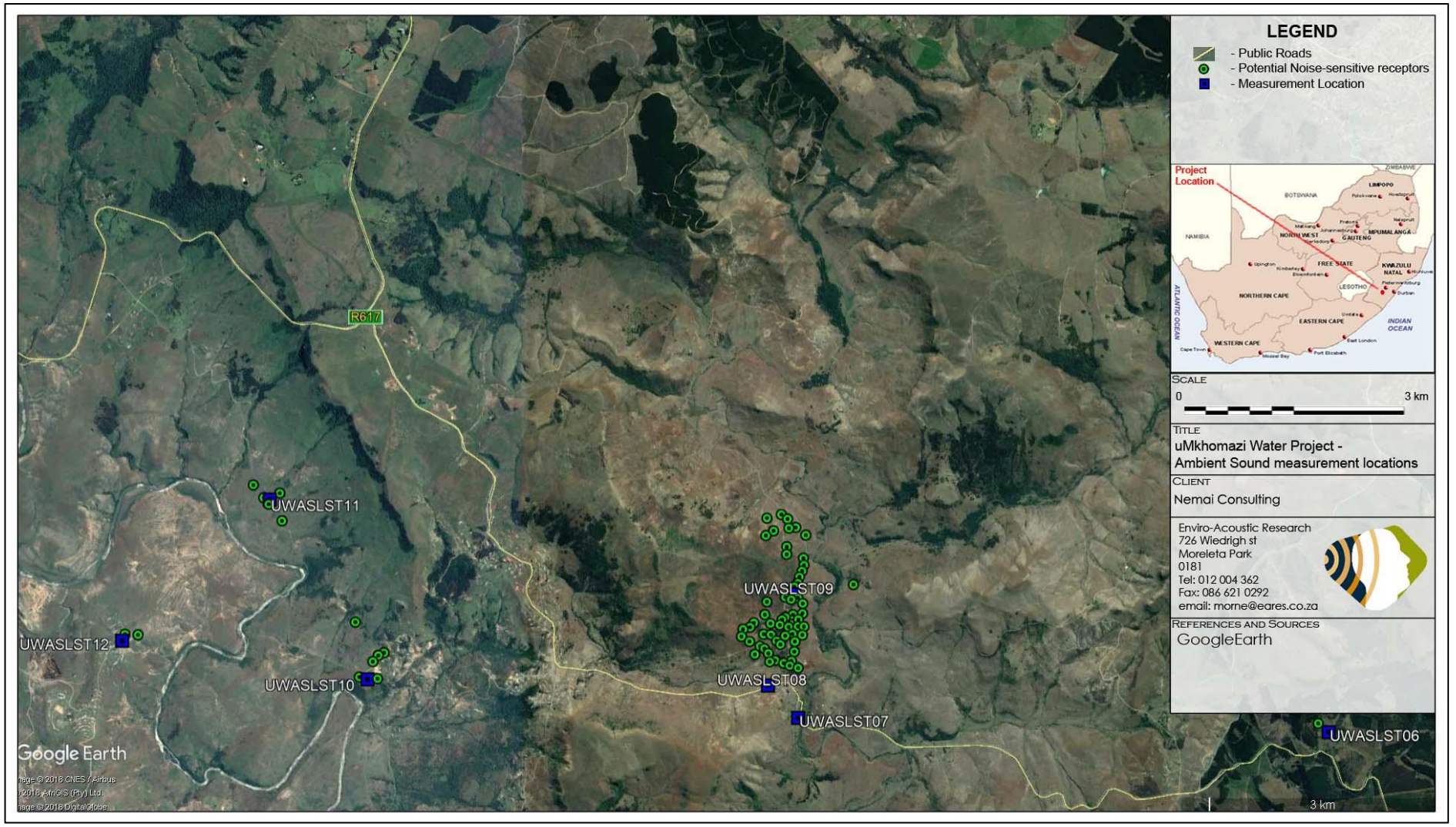

Figure 3-3: Localities where ambient sound levels were measured – Western Area

Table 3-1: Summary of Singular Noise Measurements[2]

Measurement Location (WGS 84 co-ordinate)	$L_{Aeq,i}$ level (dBA)	$L_{Aeq,f}$ level (dBA)	L_{A90} Level (dBA90)	Spectral Character	Comments
UWASLST01	41	35	27	**Figure 3-4**	Various bird calls dominate. Wind induced noises at times. Wind gusts not appearing to impact on measurements. Maximum noise level due to sounds from various birds in vicinity. Sound of flowing river just audible.
(-29.744659°, 30.208768°)	38	34	27		Humidity: 55%, Temperature: 25 ^{O}C, Wind speed: 1 - 3 m/s.
UWASLST02	35	32	27	**Figure 3-5**	Very quiet location when wind speeds are low. Wind induced noises significant and dominant at times. Sound from various bird audible. Sound from water flowing audible. Woman walking past second measurement.
(-29.770888°, 30.195362°)	32	29	26		Humidity: 58%, Temperature: 22 ^{O}C, Wind speed: 2 - 7 m/s.
UWASLST03	30	25	20	**Figure 3-6**	Extremely quiet environment. Bird call clearly audible and dominant sound. Slight rustle just audible from wind induced noises from forest. Almost no wind and quite misty. Maximum noise due to birds chirping close to measurement location.
(-29.779900°, 30.271100°)	34	28	20		Humidity: 65%, Temperature: 22.6 ^{O}C, Wind speed: 1 - 3 m/s.
UWASLST04	37	36	33	**Figure 3-7**	Wind induced noises in higher trees though ground level wind speed is 1 - 3 m/s. Wind induced noises dominant with bird sounds the origin of maximum noises. Bird sounds clearly audible.
(-29.777398°, 30.251221°)	36	36	32		Humidity: 80%, Temperature: 18.7 ^{O}C, Wind speed: 1 - 3 m/s.
UWASLST05	56	49	36	**Figure 3-8**	Location close to houses. Sounds from birds and insects dominant. No wind induced noises. Pump clearly audible. Maximum noises from birds. Agricultural equipment just audible in distance most of first measurement.
(-29.780131°, 30.311874°)	48	44	36		Humidity: 77%, Temperature: 21.7 ^{O}C, Wind speed: less than 1 m/s.
UWASLST06	40	33	25	**Figure 3-9**	Bird sounds dominate. Wind induced noises from trees at house (eucalyptus). Dogs at house clearly audible at times. Voices in distance just audible. Chopping of trees audible at times.
(-29.785104°,	39	31	25		

[2] More than one measurement was taken at each location, with each sub-row (at each measurement location row) giving the result of a particular measurement (e.g. measurement one, etc.)

Measurement Location (WGS 84 co-ordinate)	$L_{Aeq,i}$ level (dBA)	$L_{Aeq,f}$ level (dBA)	L_{A90} Level (dBA90)	Spectral Character	Comments
30.089901°)					Humidity: 61%, Temperature: 25.1 ^{O}C, Wind speed: 0 - 2 m/s.
UWASLST07	62	52	39	**Figure 3-10**	Constant sound from the river with flowing water clearly audible. Bird sounds likely dominant. Passing vehicle around every 5 minutes. With one hooting during passing. Voices just audible at times. Chickens audible from community.
(-29.783328°, 30.017839°)	44	42	38		Humidity: 56%, Temperature: 26.3 ^{O}C, Wind speed: 3 - 5 m/s.
UWASLST08	55	52	30	**Figure 3-11**	Lots of sounds from birds. Voices from community clearly audible from area. Rooster crowing in area. Donkey baying during first measurement. Two (2) Vehicles speeding past first measurement. Hammering in distance. Wind speed dropping to 3-5 m/s second measurement. One (1) vehicle during second measurement with a vehicle audible in distance.
(-29.779526°, 30.013743°)	49	44	29		Humidity: 56%, Temperature: 26.4 ^{O}C, Wind speed: 4 - 6 m/s.
UWASLST09	48	45	39	**Figure 3-12**	Significant wind-induced noises. Lots of birds dominant at times. Wind speed 4-5 m/s. Voices from community. Wind induced noises dominant as the wind blew directly from river with a number of trees in the river. Number of community members approaching and sound level of voices increasing. Wind induced noises significant.
(-29.768804°, 30.017401°)	50	46	41		Humidity: 53%, Temperature: 26.2 ^{O}C, Wind speed: 4 - 5 m/s.
UWASLST10	41	39	33	**Figure 3-13**	Birds and voices from community likely dominant sound source. Some wind induced noises at times. Wind speed 4 -6 m/s. Insects audible at times. Voices appeared to be leas during second measurement. Rooster starting to crow a few times. Donkey baying just audible. Voices picking up again.
(-29.778693°, 29.959317°)	41	37	31		Humidity: 54%, Temperature: 2913 ^{O}C, Wind speed: 4 - 6 m/s.
UWASLST11	41	34	25	**Figure 3-14**	Bird call dominant. Sheep bleating audible at times. Insects audible. Cattle mooing at times. Wind speeds less than 2 m/s. Water flowing barely audible.
(-29.757506°, 29.945900°)	48	44	27		Vehicle passing second measurement.
	39	32	25		Humidity: 54%, Temperature: 29.1 ^{O}C, Wind speed: Less than 2 m/s.

Measurement Location (WGS 84 co-ordinate)	$L_{Aeq,i}$ level (dBA)	$L_{Aeq,f}$ level (dBA)	L_{A90} Level (dBA90)	Spectral Character	Comments
UWASLST12	56	52	37	**Figure 3-15**	Direct wind noises impacting on measurements. Cattle walking in area. Voices just audible. Birds audible at times. It was reported that significant wind is normal for the area.
(-29.774100°, 29.925901°)	43	41	34		Measurement 1 - Humidity: 66%, Temperature: 24.4 ^{O}C, Wind speed: 5 - 6 m/s. Measurement 2 - Humidity: 69%, Temperature: 23.1 ^{O}C, Wind speed: 6 - 7 m/s.

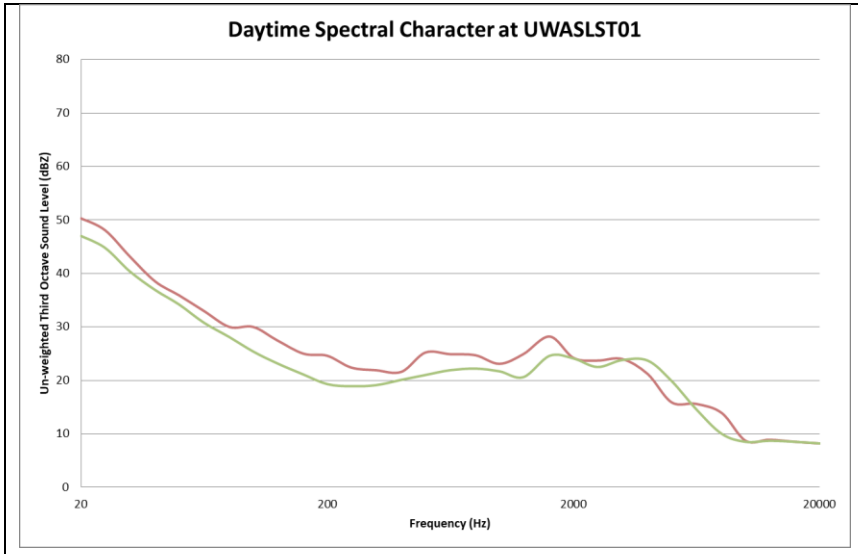

Figure 3-4: Spectral frequencies recorded at UWASLST01

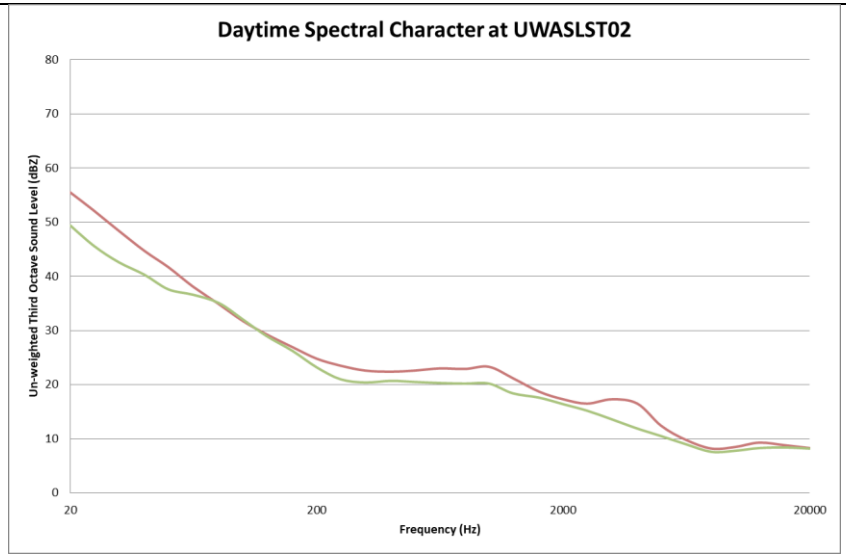

Figure 3-5: Spectral frequencies recorded at UWASLST02

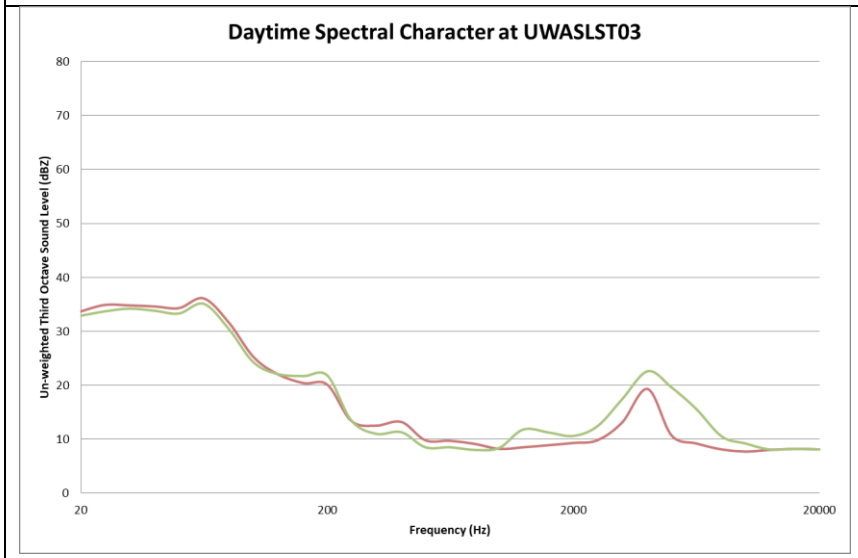

Figure 3-6: Spectral frequencies recorded at UWASLST03

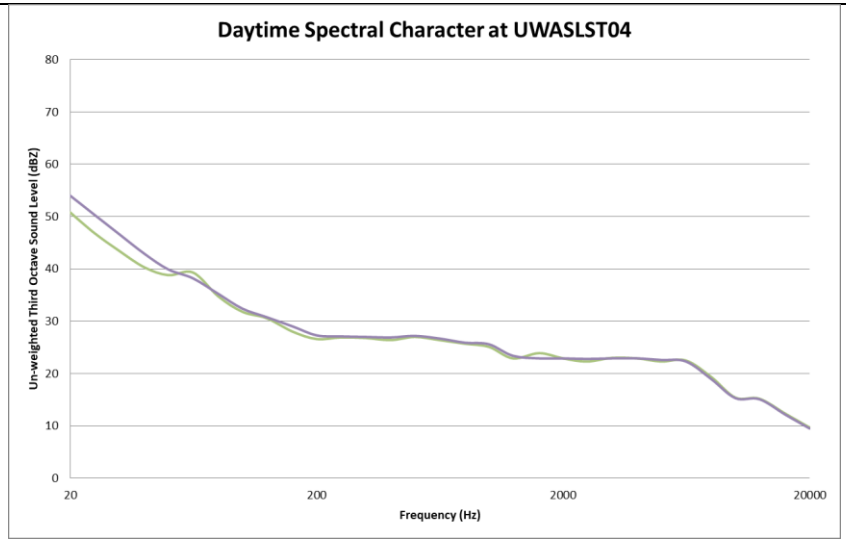

Figure 3-7: Spectral frequencies recorded at UWASLST04

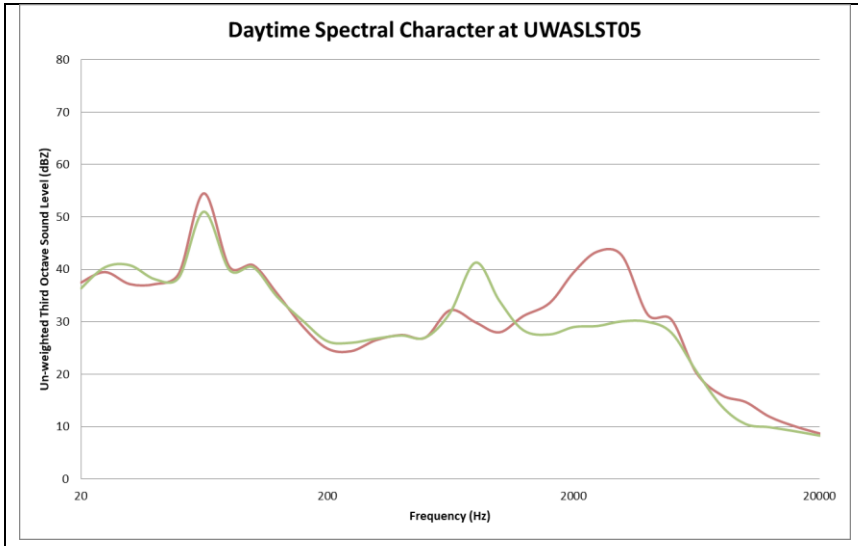

Figure 3-8: Spectral frequencies recorded at UWASLST05

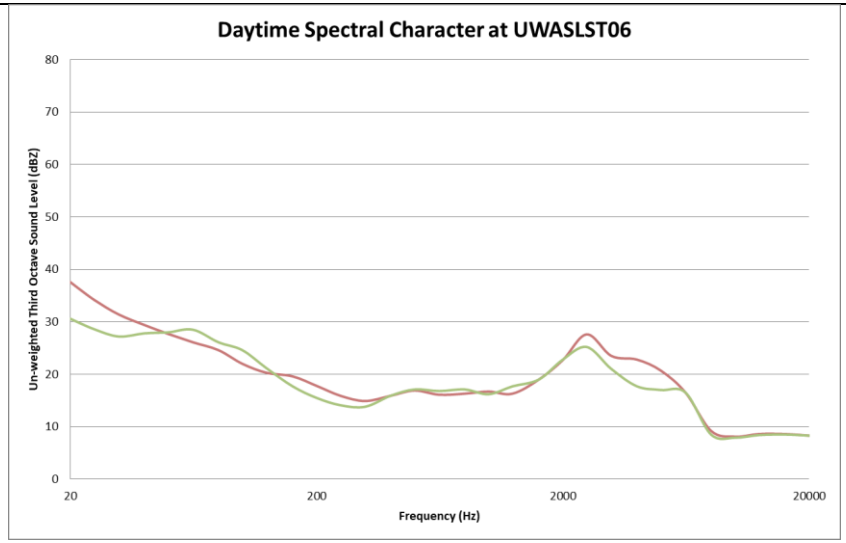

Figure 3-9: Spectral frequencies recorded at UWASLST06

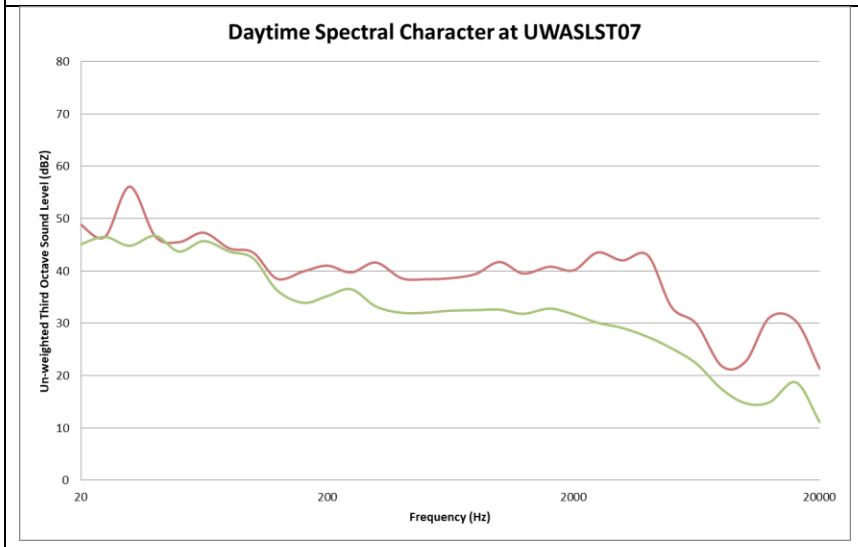

Figure 3-10: Spectral frequencies recorded at UWASLST07

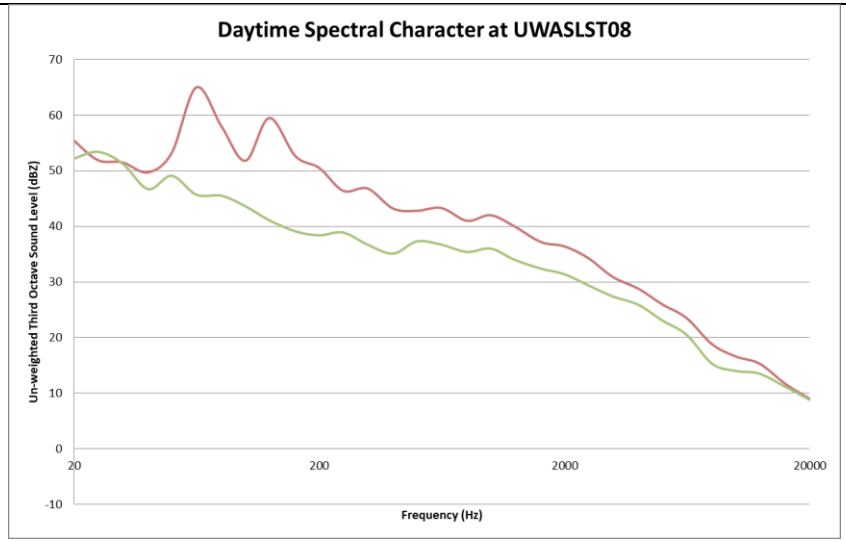

Figure 3-11: Spectral frequencies recorded at UWASLST08

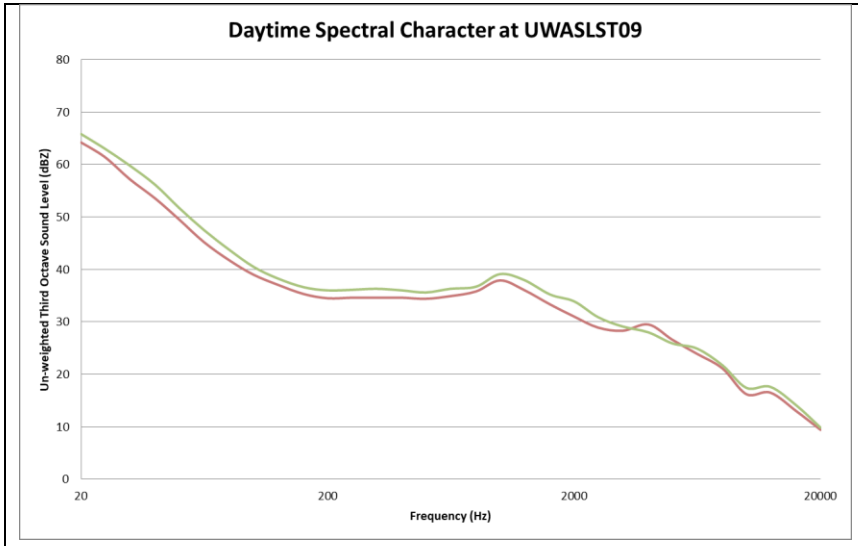

Figure 3-12: Spectral frequencies recorded at UWASLST09

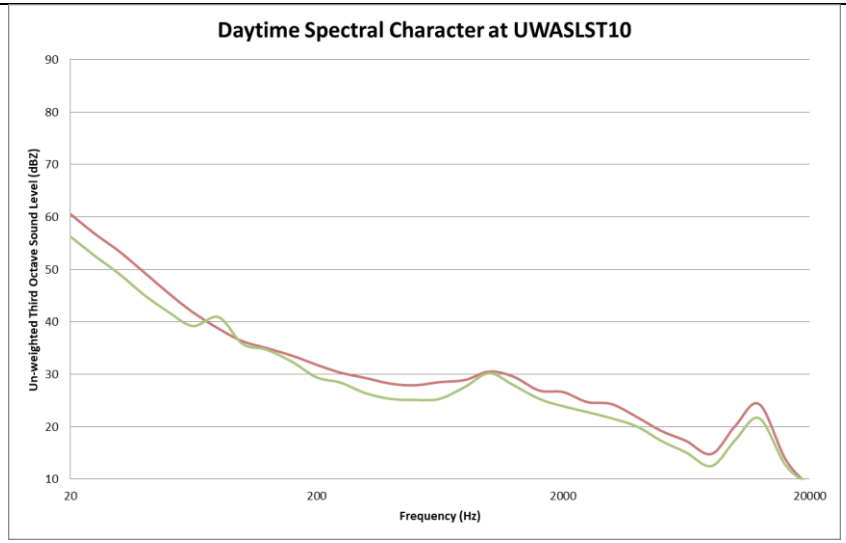

Figure 3-13: Spectral frequencies recorded at UWASLST10

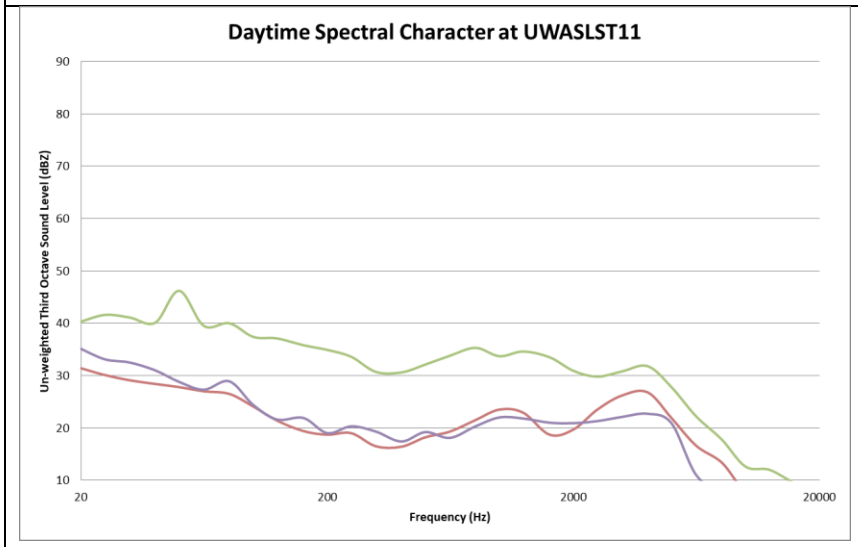

Figure 3-14: Spectral frequencies recorded at UWASLST11

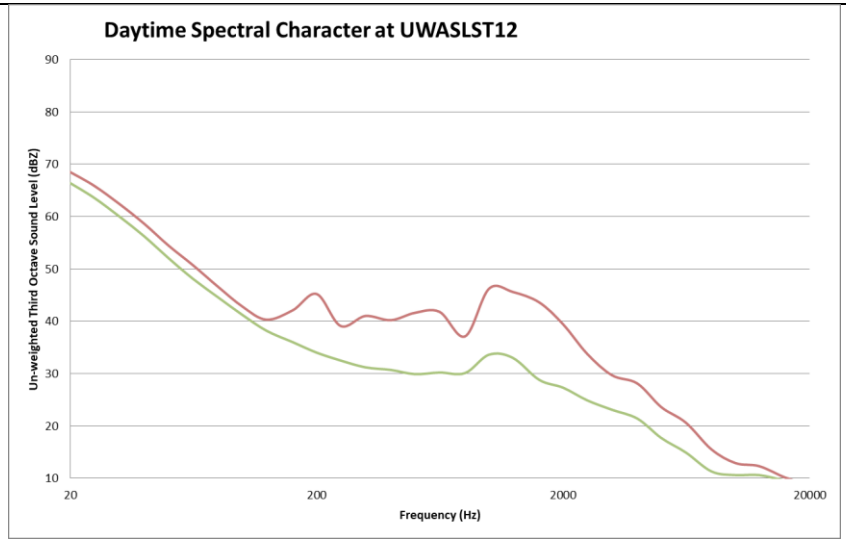

Figure 3-15: Spectral frequencies recorded at UWASLST12

4 POTENTIAL NOISE SOURCES

4.1 EXISTING SOUNDSCAPE

Considering the L_{A90} statistical sound level descriptor, the area is generally very quiet. Excluding measurement location UWASLST04, other measurement locations (where the L_{A90} statistical sound level is higher) are all located close to houses where vehicular movement, voices and/or animal sounds impacted on the measurements. Wind-induced noises dominated the sound character at UWASLST04.

4.2 POTENTIAL NOISES SOURCES: PLANNING AND DESIGN

It is assumed that planning activities would mainly include traffic and activities associated with various environmental and other investigations related to the uMWP-1. These noises will impact on the ambient sound levels during the event, but the noises are generally highly temporary and will not result in a long-term change in ambient sound levels.

4.3 POTENTIAL NOISES SOURCES DURING CONSTRUCTION

The level and character of the construction noise will be highly variable as different construction activities with different equipment will take place at different times, for different periods of time (operating cycles), in different combinations/sequences and at different locations on the construction sites.

The potential extent and impact of construction noises depends on numerous factors, including, amongst others, the prevailing ambient sound levels during the instance when the maximum noise event occurred and the character of the noise.

Maximum noises generated can be audible over a large distance; however, it is generally of very short duration. If the maximum noise levels, however, exceed 65 dBA at a receptor, or if it is clearly audible with a significant number of instances where the noise level exceeds the prevailing ambient sound level with more than 15 dBA, the noise can increase annoyance levels and may ultimately result in noise complaints (or raise the stress levels of animals). Potential maximum noise levels generated by various construction equipment as well as the potential extent of these sounds are given in **Table 4-1** below.

Average, or equivalent, sound levels are another factor that impacts on the ambient sound levels and is the constant sound level that the receptor can experience. Typical sound power levels associated with various activities that may be found at a construction site are given in **Table 4-2** below.

4.3.1 Expected Construction Activities

The following are the likely main construction related sources on noise that could add to the existing noises (existing operational activities) in the area:

- Vegetation removal and the stripping of topsoil at the quarries, borrow areas, adit, ventilation shafts and the embankment areas. Equipment that may operate simultaneously may include: bulldozer/grader, excavators, Front-end Loaders (FELs), Articulated Dump Trucks (ADTs), water trucks, etc. Topsoil will be stockpiled in the area to be used for rehabilitation and landscaping purposes at the end of construction;
- Drilling of hard rock to prepare for blasting:
- Initial drilling of the tunnel with the Tunnel Boring Machine (TBM) (as it enters the tunnel noise levels will reduce)
- Blasting activities;
- Loading of blasted rock using excavators and dump trucks. Loaded rock may be used as aggregate for the construction of the dam embankments;
- Continued activities supporting the TBM;
- Excavation of trenches and foundations;
- Formwork, engineering, concrete mixing and pouring, as well as
- Rehabilitation and landscaping

Excluding the noises from the ventilation fans, once the TMBs are located within the tunnel, noise from the tunnel boring activities will be minimal, mainly relating to ancillary activities. The ventilation fans may be audible during the construction period.

4.3.2 Blasting

Rock blasting may be required to break down rock. However, blasting will not be considered as part of the noise impact assessment for the following reasons:

- A vibration specialist would be appointed to assess the impact of blasting on the Blue Swallows;
- Blasting is highly regulated and control of blasting to protect human health, equipment and infrastructure will ensure that any blasts will use minimum explosives and will occur in a controlled manner;
- Blasting is a highly specialised field, and various management options are available to the blasting specialist. Options available to minimise the risk to equipment, people and infrastructure includes the following:
    - The use of different explosives that have a lower detonation speed, which reduces vibration, sound pressure levels as well as air blasts.
    - Blasting techniques such as blast direction and/or blast timings (both blasting intervals and sequence).
    - Reducing the total size of the blast.
    - Damping materials used to cover the explosives.

- People are generally more concerned over ground vibration and air blast levels that might cause building damage than the impact of the noise from the blast. This is normally associated with close proximity to mining/quarrying.
- Blasts will be an infrequent occurrence, with a loud but a relative instantaneous character. Potentially affected parties normally receive sufficient notice (siren), and the knowledge that the duration of the siren noise as well as the blast will be over relative fast result in a higher acceptance of the noise.

4.3.3 Vibrations

The South African Standards for vibration are limited to the SABS ISO 4866:1990 and SABS ISO 2631-1:1991. These documents are based on human and building infrastructure that is exposed to vibrations. It is a trend in African countries to refer to international standards and guidelines in terms of vibration criteria.

Infrastructure vibrations predominately occur below 300 Hz, with many international guidelines highlighting the need to consider the measurement frequency weighting when assessing vibrations (relating more to railway bound vehicles).

A ground-borne vibration is a system interlinking the noise source, vibration medium and receiver with one another. Several different mechanisms constitute this system including the distances, infrastructure specifications and noise source under investigation's *modus operandi*. There are many factors involved in the sophisticated estimation of vibration and ground-borne vibration, including[3]:

1. The medium, which entails the surrounding geological strata, bedrock depth, soil type, bedrock contours, soil layering, depth of the water table etc.;
2. The source, which is the noise sources that are under investigation etc., and
3. The receiver, which entails the receptor's foundation design, building construction, interior acoustical absorption and locations of buildings, etc.

The Vibration Impact Assessment for the uMWP-1's Raw Water Component was investigated and completed by a Vibration Specialist.

4.3.4 Construction and Access Roads

The main source of traffic noise during the construction phase relates to construction traffic in and around the uMWP-1 Project Area. The access routes' acoustical contribution to the surrounding sound environment depends on a host of factors ranging from road traffic volumes, vehicle specifications (tyre design, light or heavy etc.), road tyre interaction specifications (including road paving design such as surface porosity, surface texture etc.), road traffic speeds and a host of other considerations. Noise levels associated with construction traffic around the project area would have a minor impact considering other construction noises and will not be discussed or considered further. Construction vehicles to and from the Project Area, and on public routes were not considered as it

[3] David A. Towers, P.E. Rail Transit Noise and Vibration; Sinan Al Suhairy. Prediction of Ground Vibration from Railways. 2000

does not fall within the scope of work. This is because construction traffic is highly variable in terms of volume, type of vehicles, speed, load, maintenance condition and operating protocols, and without significant details projected noise levels cannot be estimated.

4.4 POTENTIAL NOISES SOURCES DURING NORMAL OPERATION AND MAINTENANCE

It is foreseen that operational noises will be limited to Operation and Maintenance (Q&M) activities, which will have minimal noise impacts and therefore the O&M noise impacts were not investigated further.

4.5 POTENTIAL NOISES SOURCES DURING REHABILITATION AFTER CONSTRUCTION

While there are numerous activities that may be taking place during rehabilitation after construction, the potential noise impact will only be discussed in general. This is because the noise impacts associated with the rehabilitation are normally less than those during construction for the following reasons:

- Final rehabilitation normally takes place only during the day, a time period when existing ambient sound levels are higher, generally masking most external noises for surrounding receptors, and
- Rehabilitation is a lesser priority in some instances and therefore less equipment and machinery remains on site (and are used simultaneously) to effect the final rehabilitation.

Table 4-1: Potential Maximum Noise Levels Generated by Construction Equipment

Equipment Description[4]	Impact Device?	Maximum Sound Power Levels (dBA)	Operational Noise Level at given distance considering potential maximum noise levels (Cumulative as well as the mitigatory effect of potential barriers or other mitigation not included – simple noise propagation modelling only considering distance) (dBA)											
			5 m	10 m	20 m	50 m	100 m	150 m	200 m	300 m	500 m	750 m	1000 m	2000 m
Auger Drill Rig	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Compactor (ground)	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Compressor (air)	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Concrete Batch Plant	No	117.7	92.7	86.7	80.6	72.7	66.7	63.1	60.6	57.1	52.7	49.2	46.7	40.6
Concrete Mixer Truck	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Concrete Pump Truck	No	116.7	91.7	85.7	79.6	71.7	65.7	62.1	59.6	56.1	51.7	48.2	45.7	39.6
Crane	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Dozer	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Drill Rig Truck	No	118.7	93.7	87.7	81.6	73.7	67.7	64.1	61.6	58.1	53.7	50.2	47.7	41.6
Drum Mixer	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Dump Truck	No	118.7	93.7	87.7	81.6	73.7	67.7	64.1	61.6	58.1	53.7	50.2	47.7	41.6
Excavator	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Flat Bed Truck	No	118.7	93.7	87.7	81.6	73.7	67.7	64.1	61.6	58.1	53.7	50.2	47.7	41.6
Front End Loader	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Generator	No	116.7	91.7	85.7	79.6	71.7	65.7	62.1	59.6	56.1	51.7	48.2	45.7	39.6
Generator (<25KVA, VMS Signs)	No	104.7	79.7	73.7	67.6	59.7	53.7	50.1	47.6	44.1	39.7	36.2	33.7	27.6
Grader	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Impact Pile Driver	Yes	129.7	104.7	98.7	92.6	84.7	78.7	75.1	72.6	69.1	64.7	61.2	58.7	52.6
Roller	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Ventilation Fan	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Vibratory Pile Driver	No	129.7	104.7	98.7	92.6	84.7	78.7	75.1	72.6	69.1	64.7	61.2	58.7	52.6

[4] Equipment list and Sound Power Level source: http://www.fhwa.dot.gov/environment/noise/construction_noise/handbook/handbook09.cfm (noise data could be sourced for a TBM)

Table 4-2: Potential Equivalent Noise Levels Generated by Various Equipment

Equipment Description	Equivalent (average) Sound Levels (dBA)	Operational Noise Level at given distance considering equivalent (average) sound power emission levels (Cumulative as well as the mitigatory effect of potential barriers or other mitigation not included – simple noise propagation modelling only considering distance) (dBA)											
		5 m	10 m	20 m	50 m	100 m	150 m	200 m	300 m	500 m	750 m	1000 m	2000 m
Bulldozer CAT D11	113.3	88.4	82.3	76.3	68.4	62.3	58.8	56.3	52.8	48.4	44.8	42.3	36.3
Bulldozer CAT D9	111.9	86.9	80.9	74.9	66.9	60.9	57.4	54.9	51.3	46.9	43.4	40.9	34.9
Bulldozer CAT D6	108.2	83.3	77.3	71.2	63.3	57.3	53.7	51.2	47.7	43.3	39.8	37.3	31.2
Concrete truck	109.6	84.7	78.7	72.6	64.7	58.7	55.1	52.6	49.1	44.7	41.1	38.7	32.6
Diesel Generator (Large - mobile)	106.1	81.2	75.1	69.1	61.2	55.1	51.6	49.1	45.6	41.2	37.6	35.1	29.1
Drilling Machine	109.6	84.6	78.6	72.6	64.6	58.6	55.1	52.6	49.1	44.6	41.1	38.6	32.6
Dumper/Haul truck - Terex 30 ton	112.2	87.2	81.2	75.2	67.2	61.2	57.7	55.2	51.7	47.2	43.7	41.2	35.2
Dumper/Haul truck - Bell 25 ton (B25D)	108.4	83.5	77.5	71.4	63.5	57.5	53.9	51.4	47.9	43.5	40.0	37.5	31.4
Excavator - Hitachi 870 (80 t)	108.1	83.1	77.1	71.1	63.1	57.1	53.6	51.1	47.5	43.1	39.6	37.1	31.1
Excavator - Hitachi 270 (30 t)	104.5	79.6	73.5	67.5	59.6	53.5	50.0	47.5	44.0	39.6	36.0	33.5	27.5
FEL - Bell L1806C	102.7	77.7	71.7	65.7	57.7	51.7	48.2	45.7	42.1	37.7	34.2	31.7	25.7
FEL - Komatsu WA380	100.7	75.7	69.7	63.7	55.7	49.7	46.2	43.7	40.1	35.7	32.2	29.7	23.7
General Noise	108.8	83.8	77.8	71.8	63.8	57.8	54.2	51.8	48.2	43.8	40.3	37.8	31.8
Grader - Operational Hitachi	108.9	83.9	77.9	71.9	63.9	57.9	54.4	51.9	48.4	43.9	40.4	37.9	31.9
JBL TLB	108.8	83.8	77.8	71.8	63.8	57.8	54.3	51.8	48.3	43.8	40.3	37.8	31.8
Road Truck	109.6	84.7	78.7	72.6	64.7	58.7	55.1	52.6	49.1	44.7	41.1	38.7	32.6
Vibrating Roller	106.3	81.3	75.3	69.3	61.3	55.3	51.8	49.3	45.8	41.3	37.8	35.3	29.3
Water Truck, CAT	113.8	88.8	82.8	76.8	68.8	62.8	59.3	56.8	53.3	48.8	45.3	42.8	36.8

5 METHODS: NOISE IMPACT ASSESSMENT AND SIGNIFICANCE

5.1 NOISE IMPACTS ON ANIMALS[5]

A significant amount of research was undertaken during the 1960's and 70's on the effects of aircraft noise on animals. While aircraft noise have a specific characteristic that might not be comparable with industrial noise, the findings should be relevant to most noise sources. A general animal behavioural reaction to aircraft noise is the startle response with the strength and length of the startle response to be dependent on the following:

- which species is exposed;
- whether there is one animal or a group of animals, and
- whether there have been some previous exposures.

Overall, the research suggests that species differ in their response to noise depending on the duration, magnitude, characteristic and source of the noise, as well as how accustomed the animals are to the noise (previous exposure).

Extraneous noises impacts on animals as it can increase stress levels and even impact on their hearing. Masking sounds may affect their ability to react to threats, compete and seek mates and reproduce, hunt and forage, communicate and generally to survive.

Unfortunately, there are numerous other factors in the faunal environment that also influence the effects of noise. These include predators, weather, changing prey/food base and ground-based disturbance, especially anthropogenic. This hinders the ability to define the real impact of noise on animals.

The only animal species studied in detail are humans, and studies are still continuing in this regard. These studies also indicate that there is considerable variation between individuals, highlighting the loss of sensitivity to higher frequencies as human's age. Sensitivity also varies with frequency with humans. Considering the variation in the sensitivity to frequencies and between individuals, this is likely similar with all faunal species. Some of these studies are repeated on animals, with behavioural hearing tests being able to define the hearing threshold range for some animals as indicated on **Figure** 5-1 below.

Only a few faunal (animal) species have been studied in a bit more detail so far, with the potential noise impact on marine animals most likely the most researched subject, with a few studies that discuss behavioural changes in other faunal species due to increased noises. Few studies indicate definitive levels where noises start to impact on animals, with most based on laboratory level research that subject animals to noise levels that are significantly higher than the noise levels these animals may experience in their environment (excluding the rare case where bats and avifauna fly extremely close to an anthropogenic noise, such as from a moving car or the blades of a wind turbine).

[5]Report to Congressional Requesters, 2005; USEPA, 1971; Autumn, 2007; Noise quest, 2010

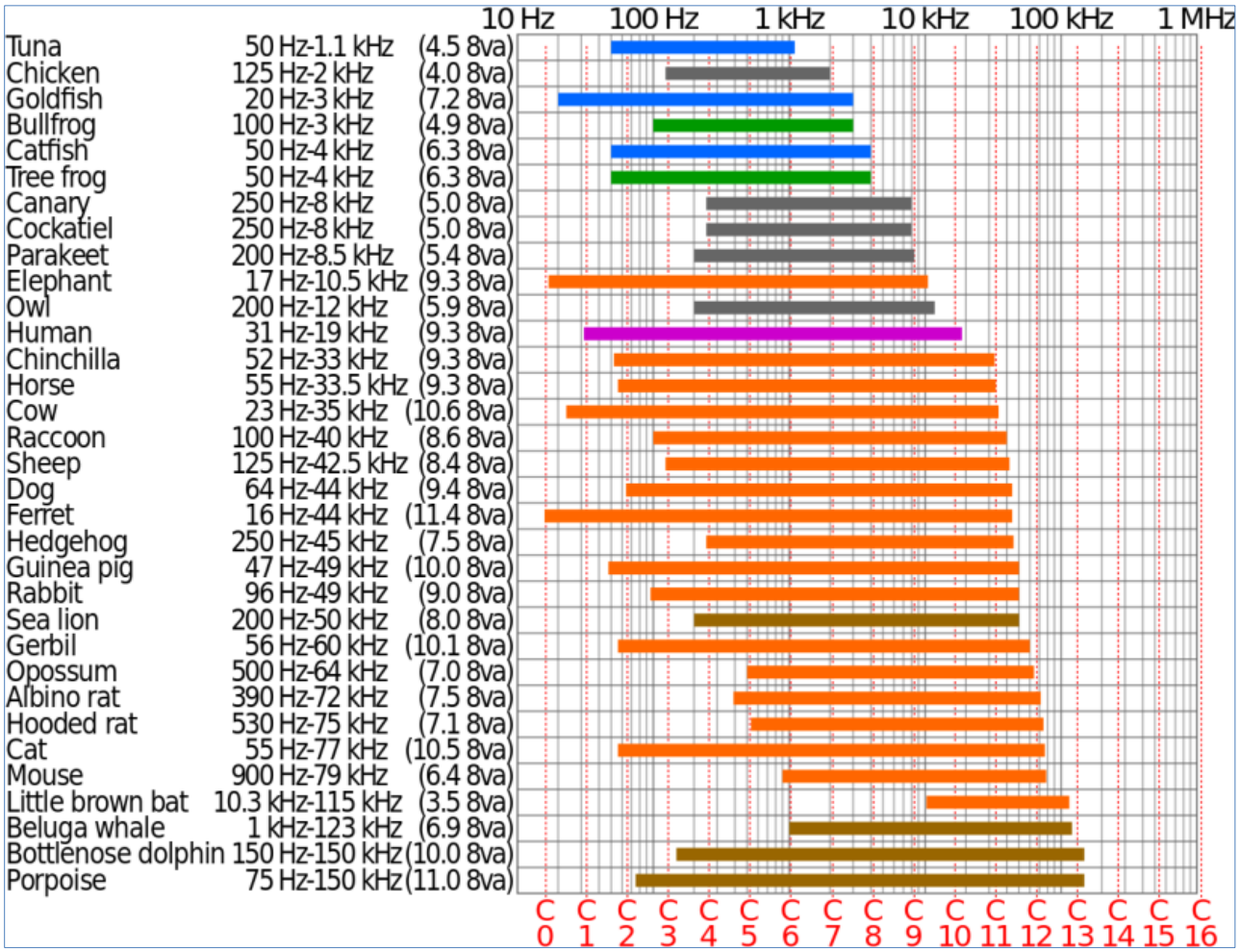

Figure 5-1: Logarithmic Chart of the Hearing Ranges of Some Animals[6]

From these and other studies the following can be concluded that:

- Animals respond to impulsive (sudden) noises (higher than 90 dBA) by running away. If the noises continue, animals would try to relocate (Drooling, 2007).
- Animals start to respond to increased noise levels with elevated stress hormone levels and hypertension. These responses begin to appear at exposure levels of 55 to 60 dBA (Baber, 2009).
- Animals of most species exhibit adaptation with noise (Broucek, 2014), including impulsive noises, by changing their behaviour.
- More sensitive species would relocate to a more quiet area, especially species that depend on hearing to hunt or evade prey, or species that makes use of sound/hearing to locate a suitable mate (Drooling, 2007).
- Noises associated with helicopters, motor- and quad bikes does significantly impact on animals. This is due to the sudden and significant increase in noise levels due to these activities.

To date there are, however, no guidelines or sound limits with regards to noise levels that can be used to estimate the potential significance of noises on animals.

[6] https://en.wikipedia.org/wiki/Hearing_range

5.1.1 Domesticated Animals

It has been observed that most domesticated animals are generally not bothered by noise, excluding most impulsive noises.

5.1.2 Wildlife

Studies indicated that most animals adapt to noises, and would even return to a site after an initial disturbance, even if the noise is continuous. The more sensitive animals that might be impacted by noise would most likely relocate to a quieter area. Noise impacts are therefore very highly species dependent.

5.1.3 Avifauna

As with other terrestrial faunal species, noise (character of sound or change in level) will impact on avifauna (birds of a particular region and/or habitat). Anthropogenic noises result in physical damage to ears, increased stress, flight or flushing, changes in foraging and other behavioral reactions. Ortega (2012) summarized that additional responses (with ecological similar controls) include the avoidance of noisy areas, changes in reproductive success and changes in vocal communication. However, as with other faunal species, there are no guidelines to assess at which sound pressure level avifaunal will start to exhibit any response.

5.1.3.1 Blue Swallows

Though the author made an effort to source available data with regard to noise impacts on Blue Swallows, there is no information, guidelines or studies covering the subject of noise impacts on this bird species. The author is not an Avifauna Specialist, and available information is sparse. Furthermore, there are no audibility curves available for the Blue Swallow species.

However, audibility curves are available for various other avifauna species (Drooling, 2002). Considering the audibility curves (absolute thresholds and bandwidths) as reported by Drooling (2002) for a number birds in the order Passeriformes, it is assumed that the audibility curve would be similar (see **Figure** 5-2 below) for the Blue Swallows. Considering the absolute audibility threshold for humans (from the Equal-loudness contours as defined by ISO 226:2003), it would be acceptable to conclude that the absolute audibility threshold of the Blue Swallow would be less sensitive than that of humans (humans are more sensitive to sound than the Passeriformes species illustrated). This study will assume noise limits (as used for humans) as the noise limit for the Blue Swallow communities in the vicinity of the Project Area (noise level exceeding 35 dBA, precautious principle).

This is a highly precautious approach, because, based on **Figure 5-2** below, if Avifauna (specifically the Blue Swallows) respond to noise levels similar as humans do, the Blue Swallows may only be disturbed at higher noise levels (40 – 45 dBA), although it is not known how the Blue Swallows may respond to increased noise levels, neither how increased noise levels may impact on nesting birds.

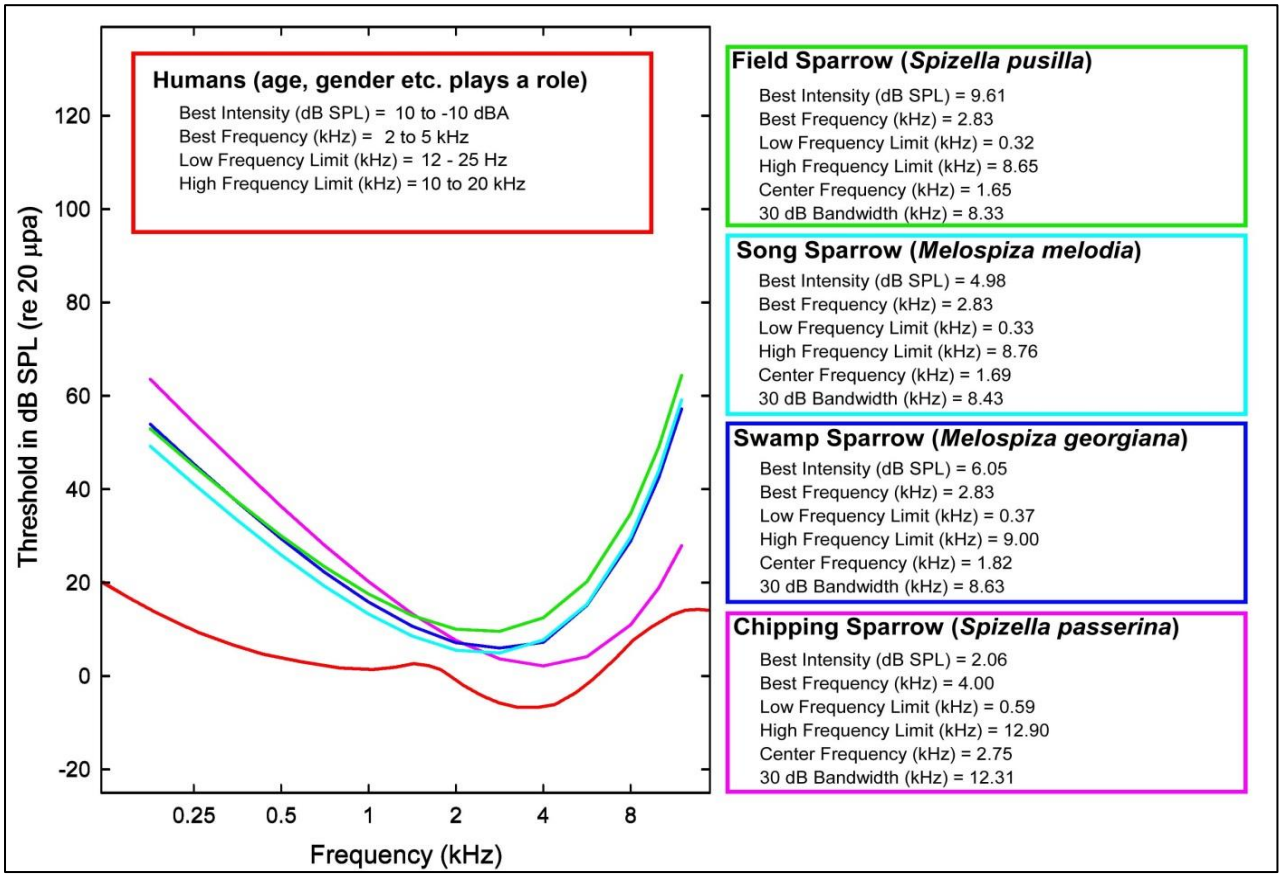

Figure 5-2: Absolute Audibility Threshold Curves for Humand and a Few Bird Species

It should be noted that Allen (2018) recommend a 1,500m buffer zone around the outer boundaries of the main Blue Swallow breeding habitat patches.

5.2 WHY NOISE CONCERNS COMMUNITIES[7]

Noise can be defined as "unwanted sound", and an audible acoustic energy that adversely affects the physiological and/or psychological well-being of people, or which disturbs or impairs the convenience and/or peace of any person. In general sound becomes unwanted when it:

- Hinders verbal communication;
- Impedes the thinking process;
- Interferes with concentration;
- Obstructs activities (work, leisure and sleeping), and
- Presents a health risk due to hearing damage.

It is important to remember that whether a given sound is "noise" depends on the listener or hearer. A car driver for example plays loud rock music on his/her car radio only hears the music, but the person in the traffic behind him/her hears nothing but noise.

Response to noise is unfortunately not an empirical absolute, as it is seen as a multi-faceted psychological concept, including behavioural and evaluative aspects. For instance, in some cases,

[7]World Health Organization, 1999; Noise quest, 2010; Journal of Acoustical Society of America, 2009

annoyance is seen as an outcome of disturbances, in other cases it is seen as an indication of the degree of helplessness with respect to the noise source.

Noise does not need to be loud to be considered “disturbing”. Even a dripping tap in the quiet of the night, or the irritating “thump-thump” of the music from a neighbouring house at night when one would like to sleep can be disturbing.

The severity of the annoyance depends on factors such as:

- Background sound levels, and the background sound levels the receptor is used to;
- The manner in which the receptor can control the noise (helplessness);
- The time, unpredictability, frequency distribution, duration, and intensity of the noise;
- The physiological state of the receptor, and
- The attitude of the receptor about the emitter (noise source).

5.3 IMPACT ASSESSMENT CRITERIA

5.3.1 Overview

The word "noise" is generally used to convey a negative response or attitude to the sound received by a listener. There are four (4) common sound characteristics, any or all of which determine listener response and the subsequent definition of the sound as "noise". These characteristics are the following:

- Intensity;
- Loudness;
- Annoyance, and
- Offensiveness.

Of these four (4) common sound characteristics, intensity is the only one that is not subjective, and can be quantified. Loudness is a subjective measure of the effect sound has on the human ear. As a quantity it is therefore complicated, but has been defined by experimentation on subjects known to have normal hearing.

The annoyance and offensive characteristics of noise are also subjective. Whether or not a noise causes annoyance mostly depends upon its reception by an individual, the environment in which it is heard, the type of activity, mood of the person and how acclimatised or familiar that person is to the sound.

5.3.2 Noise Criteria of Concern

The criteria used in this Report were drawn from the criteria for the description and assessment of environmental impacts considering the latest EIA Regulations, SANS 10103:2008 as well as guidelines from the WHO.

There are a number of criteria that are of concern for the assessment of noise impacts. These can be summarised as follows:

- *Increased in noise levels:* People or communities often react to an increase in the ambient noise level they are used to, which is caused by a new source of noise. With regards to the Noise Control Regulations (promulgated in terms of the ECA), an increase of more than 7 dBA is considered a disturbing noise, see **Figure 5-3** below.
- *Zone Sound Levels:* Previously referred to as the acceptable rating levels, it sets acceptable noise levels for various areas, .see **Table 5-1** below.
- *Absolute or total noise levels:* Depending on their activities, people generally are tolerant to noise up to a certain absolute level, e.g. 65 dBA, and anything above this level will be considered unacceptable.

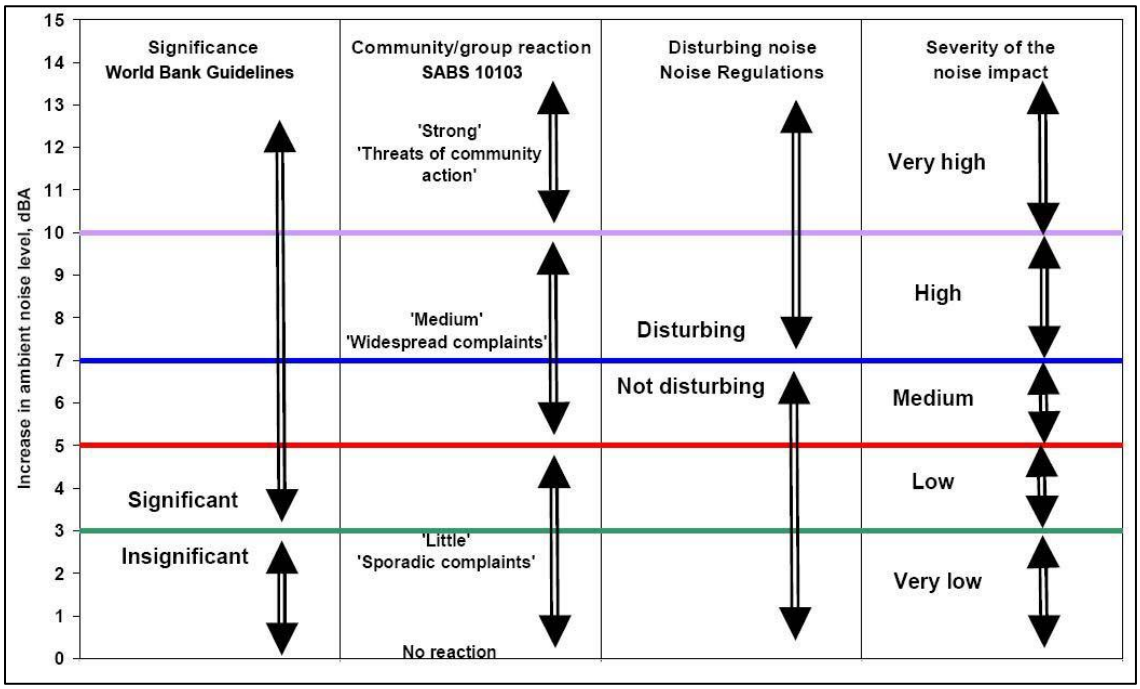

Figure 5-3: Criteria to Assess the Significance of Impacts Stemming from Noise

SANS 10103:2008 addresses the issues concerning environmental noise In South Africa. It provides the equivalent ambient noise levels (referred to as Rating Levels), $L_{Req,d}$ and $L_{Req,n}$, during the day and night respectively to which different types of developments may be exposed.

SANS 10103:2008 also provides a guideline for estimating community response to an increase in the general ambient noise level caused by an intruding noise. If Δ is the increase in sound level, the following criteria are of relevance:

- **Δ ≤ 3 dBA:** An increase of 3 dBA or less will not cause any response from a community. It should be noted that for a person with average hearing acuity an increase of less than 3 dBA in the general ambient noise level would not be noticeable.
- **3 < Δ ≤ 5 dBA:** An increase of between 3 dBA and 5 dBA will elicit 'little' community response with 'sporadic complaints'. People will just be able to notice a change in the sound character in the area.

- **5 < Δ ≤ 15 dBA:** An increase of between 5 dBA and 15 dBA will elicit a 'medium' community response with 'widespread complaints'. In addition, an increase of 10 dBA is subjectively perceived as a doubling in the loudness of a noise. For an increase of more than 15 dBA the community reaction will be 'strong' with 'threats of community action'.

Note that an increase of more than 7 dBA is defined as a disturbing noise and prohibited (National and Provincial Noise Control Regulations).

Acoustical measurements and the site investigations, based on the character of area, indicated that the noise rating of the larger area would be typical of a rural noise district (45 and 35 dBA day/night-time rating). Construction activities should not exceed the equivalent continuous rating level for noise for a rural noise district (SANS 10103:2008) with more than 5 dBA at the location of residential dwellings as well as the existing and potential (previous) Blue Swallow nesting sites.

Ambient sound levels are higher in the communities and close to houses. As such the noise rating of these areas would be typical of a suburban noise district (50 and 40 dBA day/night-time rating). Construction activities should not exceed the equivalent continuous rating level for noise for a suburban noise district (SANS 10103:2008) with more than 5 dBA at residential houses.

5.3.3 Other Noise Sources of Significance

In addition, other noise sources that may be present should also be considered. During the day, people are generally bombarded with the sounds from numerous sources considered "normal", such as animal sounds, conversation, amenities and appliances (TV/Radio/CD playing in background, computer(s), freezers/fridges, etc.). This excludes activities that may generate additional noise associated with a normal day.

At night, sounds that are present are natural sounds from animals, wind as well as other sounds we consider "normal", such as the hum from a variety of appliances (magnetostriction) drawing standby power, freezers and fridges.

Table 5-1: Acceptable Zone Sound Levels for Noise in Districts (SANS 10103:2008)

1	2	3	4	5	6	7
Type of district	**Equivalent continuous rating level ($L_{Req.T}$) for noise** dBA					
	Outdoors			**Indoors, with open windows**		
	Day/night $L_{R,dn}$[a]	**Daytime $L_{Req,d}$[b]**	**Night-time $L_{Req,n}$[b]**	**Day/night $L_{R,dn}$[a]**	**Daytime $L_{Req,d}$[b]**	**Night-time $L_{Req,n}$[b]**
a) Rural districts	45	45	35	35	35	25
b) Suburban districts with little road traffic	50	50	40	40	40	30
c) Urban districts	55	55	45	45	45	35
d) Urban districts with one or more of the following: workshops; business premises; and main roads	60	60	50	50	50	40
e) Central business districts	65	65	55	55	55	45
f) Industrial districts	70	70	60	60	60	50

5.3.4 Determining the Significance of the Noise Impact

The level of detail as depicted in the EIA Regulations was fine-tuned by assigning specific values to each impact. In order to establish a coherent framework within which all impacts could be objectively assessed, it was necessary to establish a rating system, which was applied consistently to all the criteria. For such purposes each aspect will be assigned a value as defined in the third column in the tables below during the ENIA stage.

The impact consequence is determined by the summing the scores of Magnitude (**Table 5-2** below), Duration (**Table 5-3** below) and Spatial Extent (**Table 5-4** below). The impact significance is determined by multiplying the Consequence Result with the Probability Score (**Table 5-5** below).

An explanation of the impact assessment criteria are given in **Tables 5.2** to **5.4** below.

Table 5-2: Impact Assessment Criteria - Magnitude

This defines the impact as experienced by any receptor. In this Report the receptor is defined as any resident in the area, but excludes faunal species.		
Rating	**Description**	**Score**
Minor	Increase in average sound pressure levels between 0 and 3 dB from the expected wind induced ambient sound level (proposed rating level). No change in ambient sound levels discernible. Total projected noise level is less than the Zone Sound Level in wind-still conditions.	2
Low	Increase in average sound pressure levels between 3 and 5 dB from the (expected) ambient sound level (proposed rating level). The change is barely discernible, but the noise source might become audible.	4
Moderate	Increase in average sound pressure levels between 5 and 7 dB from the (expected) ambient sound level (proposed rating level). Sporadic complaints expected. Any point where the zone sound levels are exceeded during wind still conditions.	6
High	Increase in average sound pressure levels between 7 and 10 dB from the (expected) ambient sound level (proposed rating level). Medium to widespread complaints expected.	8
Very High	Increase in average sound pressure levels higher than 10 dB from the (expected) ambient sound level (proposed rating level). Change of 10 dBA is perceived as 'twice as loud', leading to widespread complaints and even threats of community or group action. Any point where noise levels exceed 65 dBA at any receptor.	10

Table 5-3: Impact Assessment Criteria - Duration

The lifetime of the impact that is measured in relation to the lifetime of the proposed development (construction, operational and closure phases). Will the receptors be subjected to increased noise levels for the lifetime duration of the project, or only infrequently?		
Rating	**Description**	**Score**
Temporary	Impacts are predicted to be of short duration (portion of construction period) and intermittent/occasional (0 - 1 years).	1
Short-term	The predicted impacts will only last for the duration of the construction period (1 - 5 years).	2
Medium-term	Impacts that will continue for a part of the operational phase, well after the construction phase stopped (5 – 15 years).	3
Long-term	Impacts that will continue for the life of the Project, but ceases when the project stops	4

	operating (> 15 years).	
Permanent	Impacts that cause a permanent change in the affected receptor or resource (e.g. removal or destruction of ecological habitat) that endures substantially beyond the project lifetime.	5

Table 5-4: Impact Assessment Criteria – Spatial Extent

Classification of the physical and spatial scale of the impact (defined as the area where the noise impact may change the ambient sound levels with 7 dBA or more)		
Rating	**Description**	**Score**
Site	The impacted area extends only as far as the activity, such as footprint occurring within the total site area.	1
Local	The impact could affect the local area (within 1,000 m from the site).	2
Regional	The impact could affect the area including the neighbouring farms, the transport routes and the adjoining towns (further than 1,000 m from the site).	3
National	The impact could have an effect that expands throughout the country (South Africa).	4
International	Where the impact has international ramifications that extend beyond the boundaries of South Africa.	5

Table 5-5: Impact Assessment Criteria - Probability

This describes the likelihood of the impacts actually occurring, and whether it will impact on an identified receptor. The impact may occur for any length of time during the life cycle of the activity, and not at any given time. The classes are rated as follows:		
Rating	**Description**	**Score**
Very Improbable	The possibility of the impact occurring is none, due to either the circumstances, design or experience. The chance of this impact occurring is zero (0 %).	1
Improbable/Possible	The possibility of the impact occurring is very low, due either to the circumstances, design or experience. The chances of this impact occurring is defined to be up to 25%.	2
Probable/Likely	There is a possibility that the impact will occur to the extent that provisions must be made for it. The chances of this impact occurring is defined to be between 25% and 50%.	3
Highly Probable/Likely	It is most likely that the impacts will occur at some stage of the development. Plans must be drawn up before undertaking the activity. The chances of this impact occurring is defined to be between 50 % to 75 %.	4
Definite	The impact will take place regardless of any prevention plans, and only mitigation actions or contingency plans to contain the effect can be relied on. The chance of this impact occurring is defined to be between 75% and 100%.	5

5.3.5 Identifying the Potential Impacts without Mitigation Measures

Following the assignment of the necessary weights to the respective aspects, criteria are summed and multiplied by their assigned probabilities, resulting in a value for each impact (prior to the implementation of mitigation measures). The Significance Rating (SR) without mitigation is rated on the scale that is given in **Table 5.6** below:

Table 5-6: Significance Rating without Mitigation

Significance Rating	Level	Description
SR < 30	Low (L)	Impacts with little real effect and which should not have an influence on, or require modification of the project design or alternative mitigation. No mitigation is required.
30 < **SR** < 60	Medium (M)	Where it could have an influence on the decision unless it is mitigated. An impact or benefit which is sufficiently important to require management. Of moderate significance - could influence the decisions about the project if left unmanaged.
SR > 60	High (H)	Impact is significant, mitigation is critical to reduce impact or risk. The resulting impact could influence the decision depending on the possible mitigation. An impact that could influence the decision about whether or not to proceed with the project.

5.3.6 Identifying the Potential Impacts with Mitigation Measures

In order to gain a comprehensive understanding of the overall significance of the impact, after implementation of the mitigation measures, it will be necessary to re-evaluate the impact. Significance with mitigation is rated on the scale that is given in **Table 5.7** below:

Table 5-7: Significance Rating with Mitigation

Significance Rating	Level	Description
SR < 30	Low (L)	Impacts with little real effect and which should not have an influence on, or require modification of the project design or alternative mitigation. No mitigation is required.
30 < **SR** < 60	Medium (M)	Where it could have an influence on the decision unless it is mitigated. An impact or benefit which is sufficiently important to require management. Of moderate significance - could influence the decisions about the project if left unmanaged.
SR > 60	High (H)	Impact is significant, mitigation is critical to reduce impact or risk. The resulting impact could influence the decision depending on the possible mitigation. An impact that could influence the decision about whether or not to proceed with the project.

5.4 REPRESENTATION OF NOISE LEVELS

Noise rating levels were calculated in the ENIA Report using the appropriate Sound Propagation Model (the ISO 9613-2 algorithm was used that is part of the SoundPlan Package). It is therefore important to understand the difference between sound, or noise, level, as well as the noise rating level (also see Glossary of Terms in **Appendix A**).

Sound, or noise, levels generally refers to a level as measured using an instrument, whereas the noise rating level refers to a calculated sound exposure level to which various corrections and adjustments were added. These noise rating levels were further processed into a 3D map illustrating noise contours of constant rating levels or noise isopleths. In this ENIA it was used to illustrate the potential extent of the calculated noises of the entire project (the uMWP-1) and not noise levels at a specific moment in time.

6 ASSUMPTIONS AND LIMITATIONS

6.1 MEASUREMENTS OF AMBIENT SOUND LEVELS

- Ambient sound levels are the cumulative effects of innumerable sounds generated from a variety of noise sources at various instances both far and near from the listener. High measurements may not necessarily mean that noise levels in the area are high. Similarly, a low sound level measurement will not necessarily mean that the area is always quiet, as sound levels will vary over seasons, time of the day, faunal characteristics, vegetation in the area and meteorological conditions (especially wind). This is excluding the potential effect of sounds from anthropogenic origin. It is impossible to quantify and identify the numerous sources that influenced one 10-minute measurement using the reading result at the end of the measurement. Therefore trying to define ambient sound levels using the result of one 10-minute measurement will be very inaccurate (very low confidence level in the results) for the reasons mentioned above. The more measurements that can be collected at a location the higher the confidence levels in the ambient sound level determined. The more complex the sound environment, the longer the required measurement, especially when at a community or house. It is assumed that the measurement locations represents ambient sound levels in the area (similar environment), yet, in practice this can be highly erroneous as there are numerous factors that can impact on ambient sound levels, including:
    - the distance to the closest trees, number and type of trees as well as the height of the trees;
    - available habitat and food for birds and other animals;
    - distance to residential dwellings, type of equipment used at dwelling (compressors, air-cons, etc.) and people in the area;
    - general maintenance condition of houses (especially during windy conditions), as well as
    - numbers and types of animals kept in the vicinity of the measurement locations.
- Determination of existing road traffic and other noise sources of significance are important (traffic counts, etc.). Traffic, however, is highly dependent on the time of day as well as general agricultural activities taking place at the time of traffic counts. Traffic noise is one of the major components in urban areas and could be a significant source of noise during busy periods. This Study found that traffic in the area was very low, yet it cannot be assumed that is always very low;
- Measurements over wind speeds of 3 m/s could provide data influenced by wind-induced noises. While the windshields used limits the effect of fluctuating pressure across the microphone diaphragm, the effect of wind-induced noises in the trees in the vicinity of the microphone did impact on the ambient sound levels. The site visit unfortunately coincided with a relatively windy period;
- Ambient sound levels are depended not only time of day and meteorological conditions, but also change due to seasonal differences. Ambient sound levels are generally higher in

summer months when faunal activity is higher and lower during the winter due to reduced faunal activity;

- Ambient sound levels recorded near rivers, streams, wetlands, trees and bushy areas can be high. This is due to faunal activity which can dominate the sound levels around the measurement location, and
- As a residential area develops the presence of people will result in increased sounds. These are generally a combination of traffic noise, voices, animals and equipment (incl. TV's and Radios). The result is that ambient sound levels will increase as a residential area matures.

6.2 CALCULATING NOISE EMISSIONS AND THE ADEQUACY OF PREDICTIVE METHODS

The noise emissions into the environment from the various sources as defined were calculated for the operational phase of the uMWP-1 in detail, using the Sound Propagation Model described in ISO 9613-2.

The following was considered in the Noise Model:

- The octave band sound pressure emission levels of processes and equipment;
- The distance of the receiver from the noise sources;
- The impact of atmospheric absorption;
- The operational details of the proposed project (the uMWP-1), such as projected areas where activities will be taking place;
- Topographical layout, as well as
- Acoustical characteristics of the ground. Fifty percent (50%) soft ground conditions were modelled, as the area where the construction activities could take place is well vegetated and sufficiently uneven to allow the consideration of relatively soft ground conditions. This is because the use of hard ground conditions could represent a too precautionary situation.

The noise emission into the environment due to additional traffic was calculated using the Sound Propagation Model described in SANS 10210. Corrections such as the following will be considered:

- Distance of receptor from the roads;
- Road construction material;
- Average vehicle speeds;
- Vehicle types, and
- Ground acoustical conditions.

It is important to understand the difference between sound, or noise level and the noise rating level (also see Glossary of Terms – **Appendix A**).

Sound, or noise levels, generally refers to a sound pressure level as measured using an instrument, whereas the noise rating level refers to a calculated sound exposure level to which various corrections

and adjustments was added. These noise rating levels are further processed into a 3D map illustrating noise contours of constant rating levels or noise isopleths. In this project it illustrate the potential extent of the calculated noises of the complete project and not noise levels at a specific moment in time. It is used to define potential issues of concern and not to predict a noise level at a potential noise-sensitive receptor. For this the selected sound propagation model is internationally recognised and considered adequate.

6.3 ADEQUACY OF UNDERLYING ASSUMPTIONS

Noise experienced at a certain location is the cumulative result of innumerable sounds emitted and generated both far and close, each in a different time domain, each having a different spectral character at a different sound level. Each of these sounds are also impacted differently upon by the surrounding vegetation, structures and meteorological conditions that result in a total cumulative noise level represented by a few numbers on a sound level meter.

As previously mentioned, it is not the purpose of noise modelling to accurately determine a likely noise level at a certain receptor, but to calculate a noise rating level that is used to identify potential issues of concern.

6.4 UNCERTAINTIES OF INFORMATION PROVIDED

While it is difficult to define the character of a measured noise in terms of numbers (third octave sound power levels), it is difficult to accurately model noise levels at a receptor from any operation. The projected noise levels are the output of a numerical model with the accuracy depending on the assumptions made during the setup of the model. The assumptions include the following:

- That octave sound power levels selected for processes and equipment accurately represent the sound character and power levels of these processes and equipment. The determination of octave sound power levels in itself is subject to errors, limitations and assumptions with any potential errors carried over to any model making use of these results;
- Sound power emission levels from processes and equipment changes depending on the load the process and equipment is subject to. While the octave sound power level is the average (equivalent) result of a number of measurements, this measurement relates to a period that the process or equipment was subject to a certain load (work required from the engine or motor to perform action). Normally these measurements are collected when the process or equipment is under high load. The result is that measurements generally represent a worse-case scenario;
- As it is unknown which processes and equipment will be operational (when and for how long), modelling considers a scenario where processes and equipment are under full load for a set time period. Modelling assumptions complies with the precautionary principle and operational time periods are frequently overestimated. The result is that projected noise levels would be likely over-estimated;
- Modelling cannot capture the potential impulsive character of a noise that can increase the potential nuisance factor;

- The XYZ topographical information is derived from the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Global DEM data, a product of Japan's Ministry of Economy, Trade, and Industry (METI) and the National Aeronautical and Space Administration (NASA). There are known inaccuracies and artefacts in the data set, yet this is still one of the most accurate data sets to obtain 3D-topographical information;
- The impact of atmospheric absorption is simplified and very uniform meteorological conditions are considered. This is an over-simplification and the effect of this in terms of sound propagation modelling is difficult to quantify, and
- Acoustical characteristics of the ground are over-simplified with ground conditions accepted as uniform. Fifty percent (50%) soft ground conditions will be modelled as the area where the construction activities are proposed is well vegetated and sufficiently uneven to allow the consideration of soft ground conditions.

7 PROJECTED NOISE RATING LEVELS

7.1 CURRENT AMBIENT SOUND LEVELS

Ambient sound levels were measured in the area and discussed in **Sub Section 3.3** above. No noise contours were developed for the area as there are no significant noise sources in the vicinity that could influence the soundscape.

7.2 PROJECTED CONSTRUCTION NOISE LEVELS

As discussed in **Sub Section 4.3** above, there are numerous potential sources of noise during the construction phase. At the start of construction a significant noise source would be the development, off-loading of equipment and material as well as the heavy vehicle traffic associated with these activities. Together with these activities there are numerous other activities that will start, including the construction of access roads, clearing of vegetation and topsoil stripping, as well as a plethora of other activities.

It is, however, a complex undertaking to model each and every potential combination of activities that could take place, and the scenario proposed include the start of construction, with the removal of vegetation and topsoil. Equipment that is normally used for this purpose includes, but are not limited to, the following:

- Graders and/or bulldozers to strip vegetation, as well as
- Excavators and Articulated Dump Trucks (ADTs) removing the topsoil and transporting it to stockpile areas. This activity, while it may not be the noisiest activity, generally takes place at ground surface without the benefit of topsoil and subsoil berms that could reduce noise levels.

The third octave sound power levels selected for the modelled scenarios are presented in **Table 7-1** below:

Table 7-1: Third Octave Sound Power Emission Levels used for Modelling

Equipment	Sound Power Level, dB re1 pW, in Octave Band, Hz							SPL
Frequency	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**(dBA)**
Articulated Dump Truck (ADT) - Bell B25D	102.5	108.6	106.5	105.4	104.5	99.2	97.2	108.4
Drilling machine and Compressor	121.6	123.3	118.3	115.3	114.2	113.9	111.3	120.8
Ventilation Fan	125.7	121.2	112.7	107.4	97.8	93.8	87.1	110.1
Excavator – Hitachi 870	108.4	108.2	110.0	104.8	102.7	97.7	97.9	108.1
General Noise	95.0	100.0	103.0	105.0	105.0	100.0	100.0	108.8
Road Truck – 30 ton	90.0	101.0	102.0	105.0	105.0	104.0	99.0	109.6

A conceptual scenario was envisioned and is illustrated in **Figure 7-1** and **Figure 7-2** below, and it should be noted that:

- Either the Mbangweni or Langa Balancing Dam will be constructed, depending on the final option selected. For the purposes of this ENIA the development of the Mbangweni Balancing Dam will be selected as this option may result in the closest noise generating activities at the identified receptors.
- The modelling output was used to assess the potential noise impact for the other potential options.
- There are a number of identified receptors that stays within the dam's FSL contour. It was assumed that these receptors will be relocated before or during construction.
- Due to the magnitude of the uMWP-1, it is divided into the following three (3) sections:
    - **Eastern Section: -** Projected daytime and night-time noise rating level contours are presented in **Figure 7-3** and **Figure 7-4** below for the conceptual scenario.
    - **Middle Section: -** Projected daytime and night-time noise rating level contours are presented in **Figure 7-5** and **Figure 7-6** below for the conceptual scenario.
    - **Western Section: -** Projected daytime and night-time noise rating level contours are presented in **Figure 7-7** and **Figure 7-8** below for the conceptual scenario.

While there are numerous other activities that could take place during construction, the conceptualised activities should account for a significant portion of the acoustic energy impacting on the surrounding environment.

7.3 PROJECTED OPERATIONAL PHASE NOISE LEVELS

There will be increased traffic and activities relating to people visiting the facilities as well as for O&M activities. While these activities will result in increased the noise levels during these events will be very temporary (compared to construction activities). Based on the experience of the author, the noise impact will be low, and it was therefore not assessed further.

7.4 REHABILITATION, DECOMMISSIONING, CLOSURE AND POST CLOSURE PHASE NOISE IMPACT

Minimal rehabilitation activities will take place after construction, as most of the disturbed areas, e.g. quarries and borrow areas, will be located inundated by the dam and will not require rehabilitation. Decommissioning, closure and post closure activities are generally far less than the construction and operational activities due to the fact these activities are not necessarily very urgent and that the activities are usually limited to daytime hours. Post closure activities are mainly limited to monitoring and maintenance, which have very low noise impacts, and therefore these activities were not investigated further.

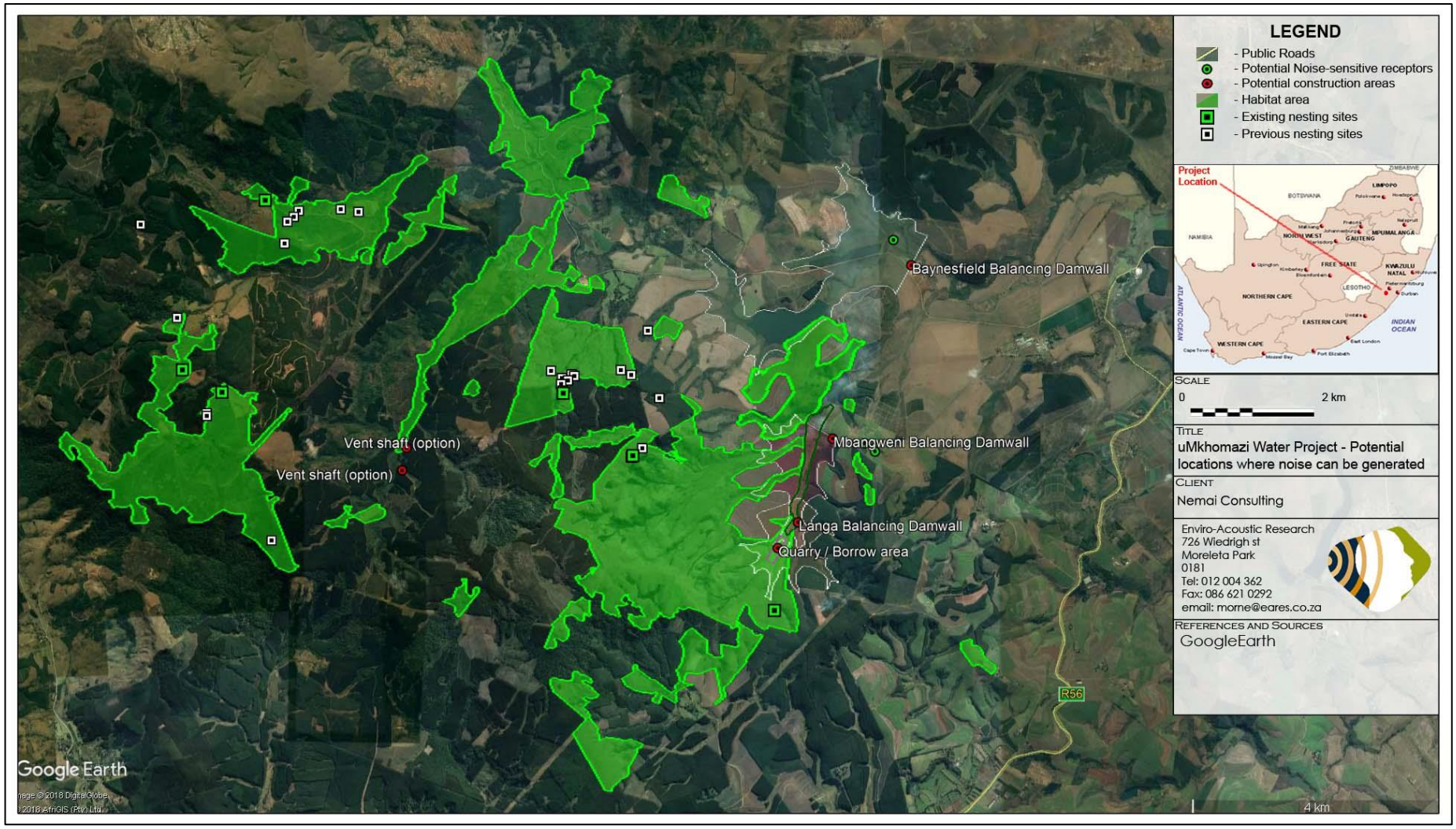

Figure 7-1: Conceptual Construction Activities in the Vicinity of the Eastern Ventilation Shaft and Balancing Dams

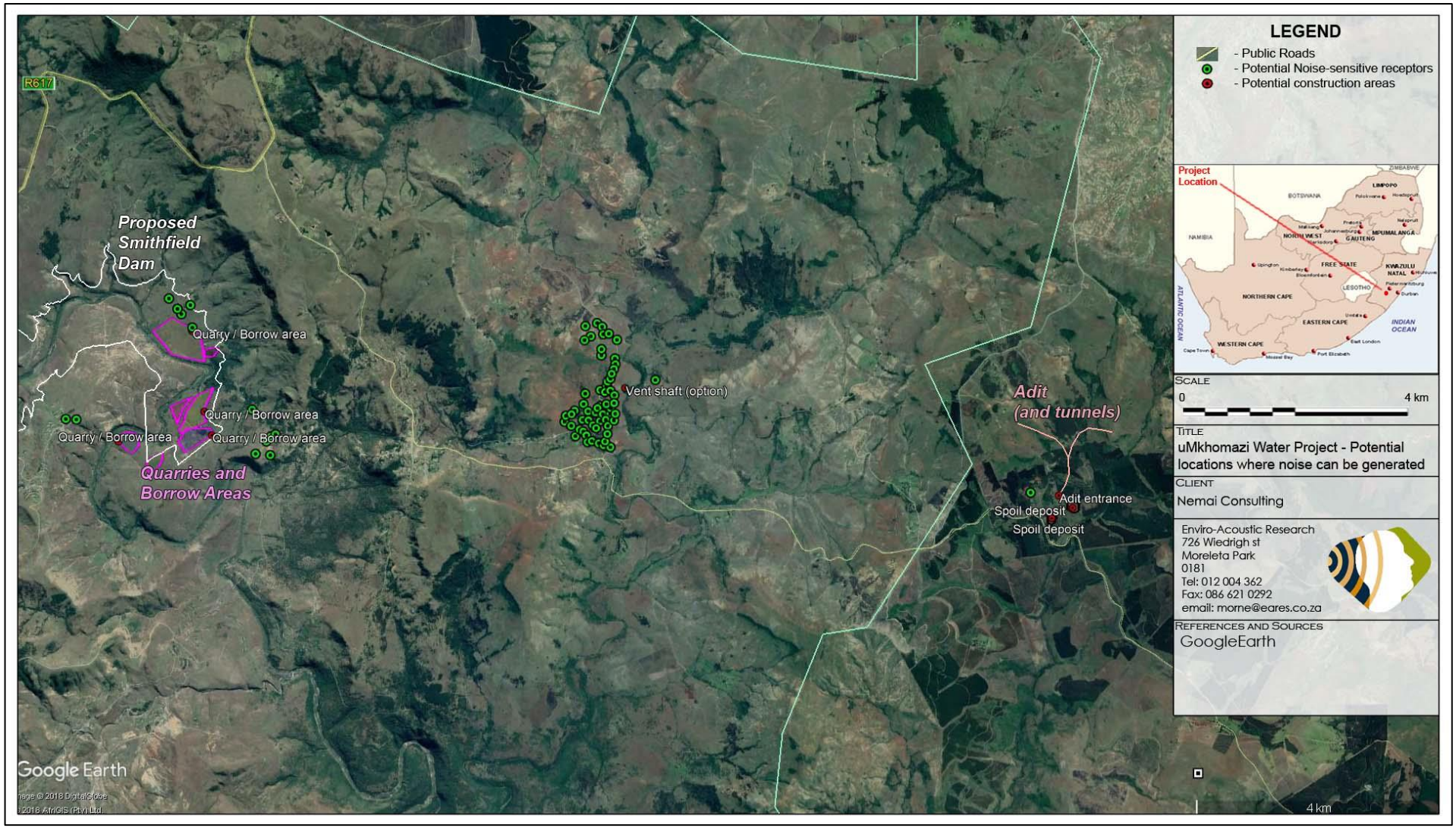

Figure 7-2: Conceptual Construction Activities at the Smithfield Dam, Western Ventilation Shaft and Adit Area

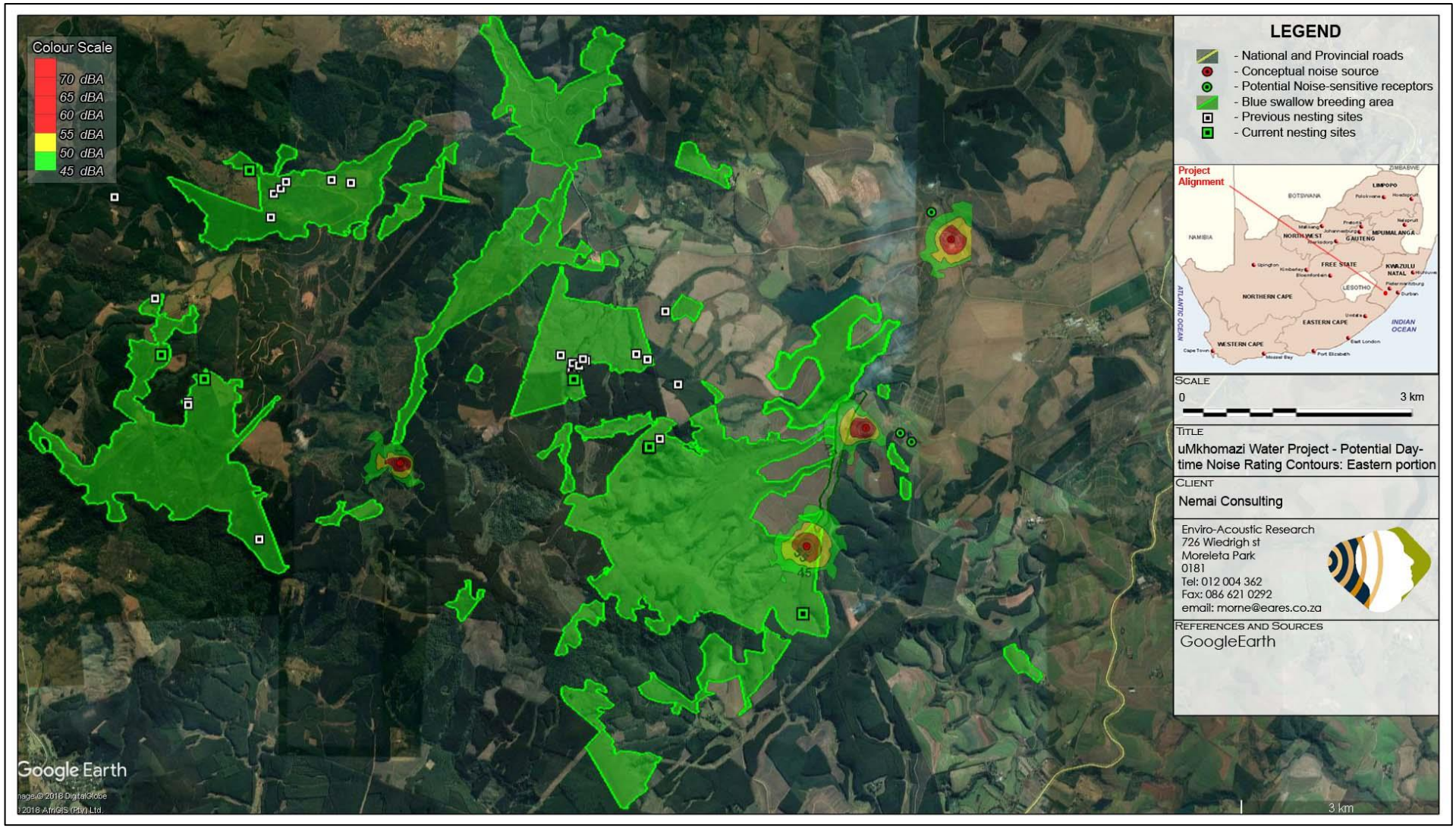

Figure 7-3: Projected Conceptual Daytime Construction Activities - Noise Rating Contour Levels (Eastern Part of the uMWP-1)

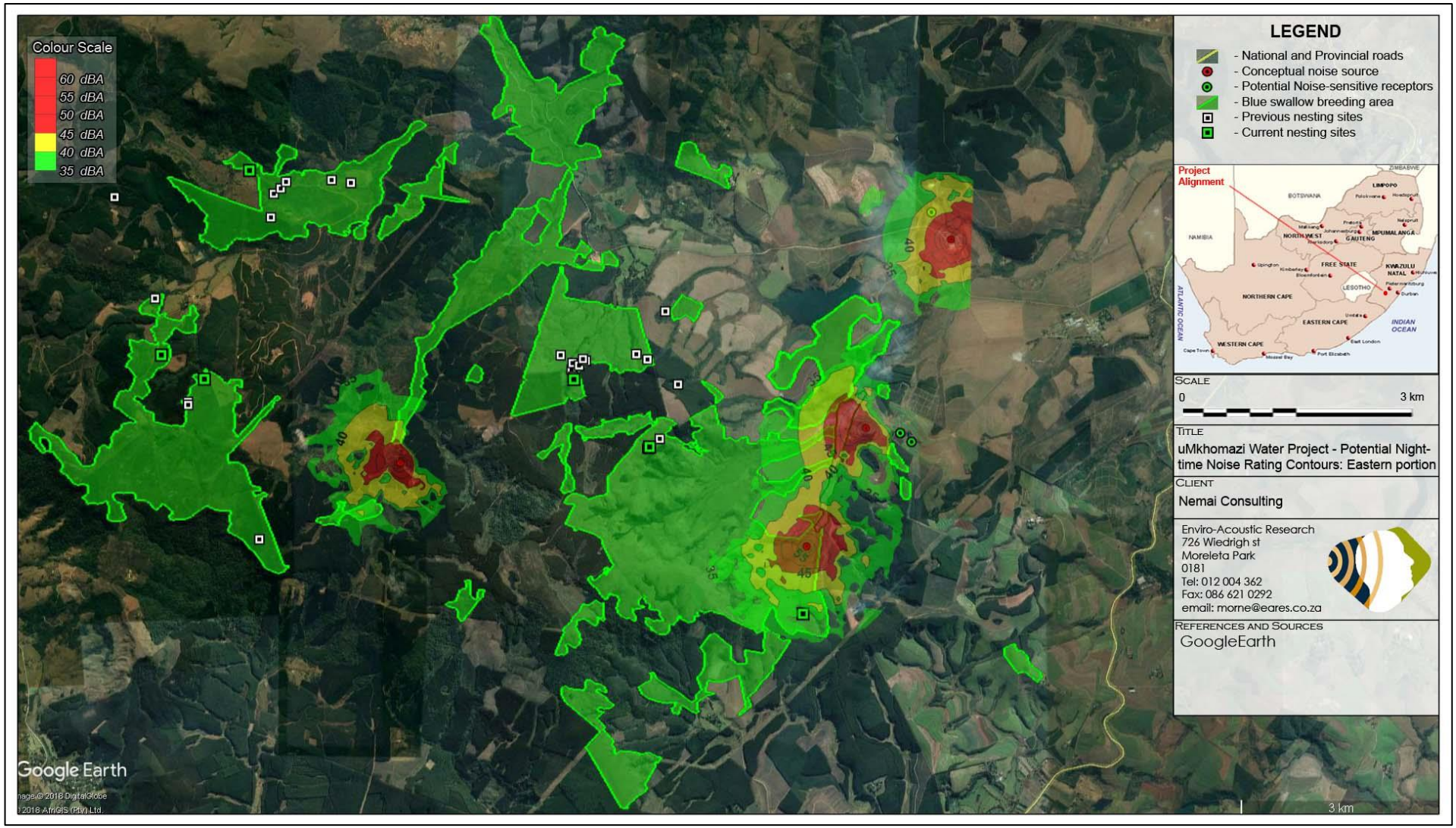

Figure 7-4: Projected Conceptual Night-time Construction Activities - Noise Rating Contour Levels (Eastern Part of the uMWP-1)

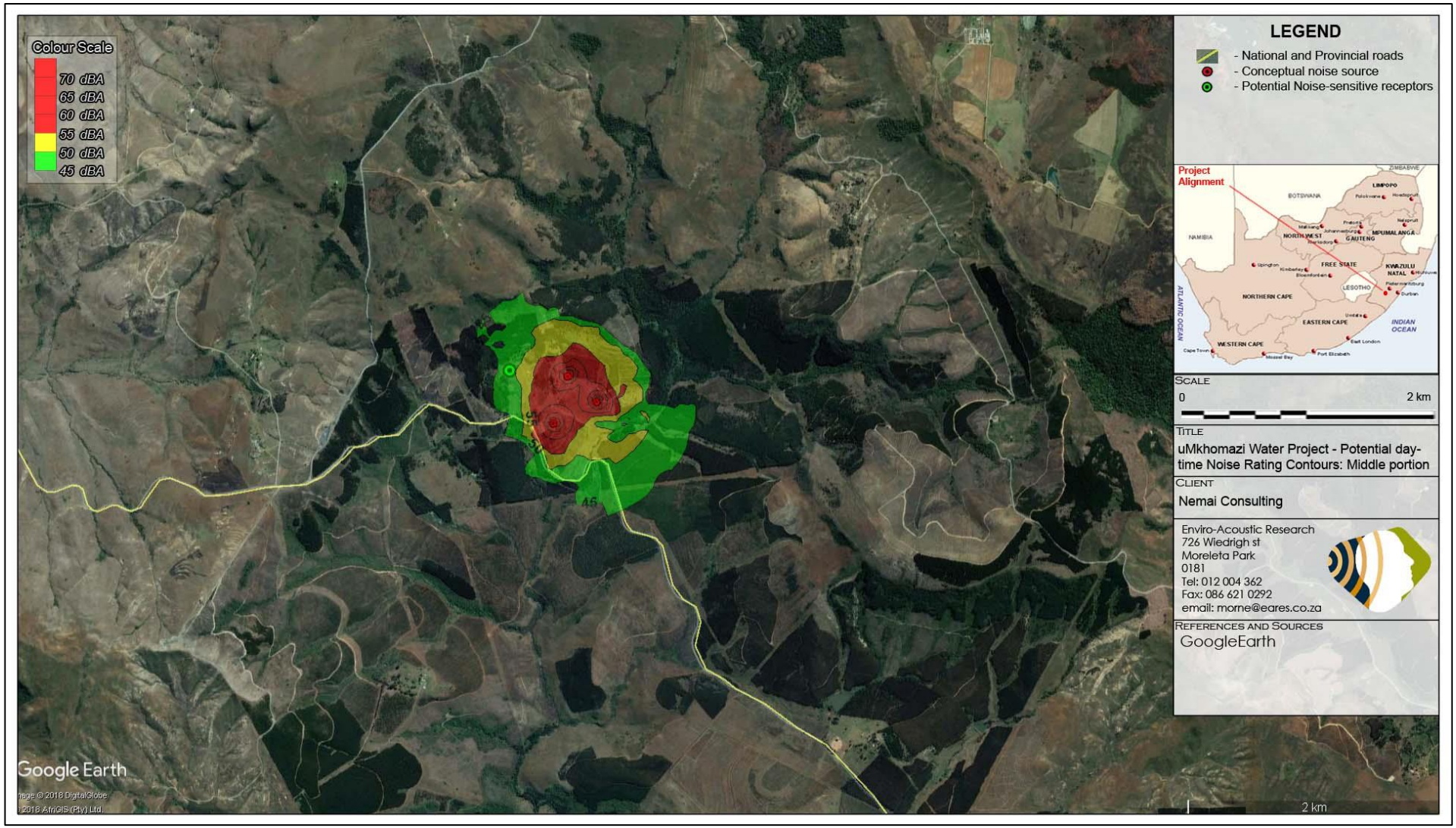

Figure 7-5: Projected Conceptual Daytime Construction Activities - Noise Rating Contour Levels (Middle Part of the uMWP-1)

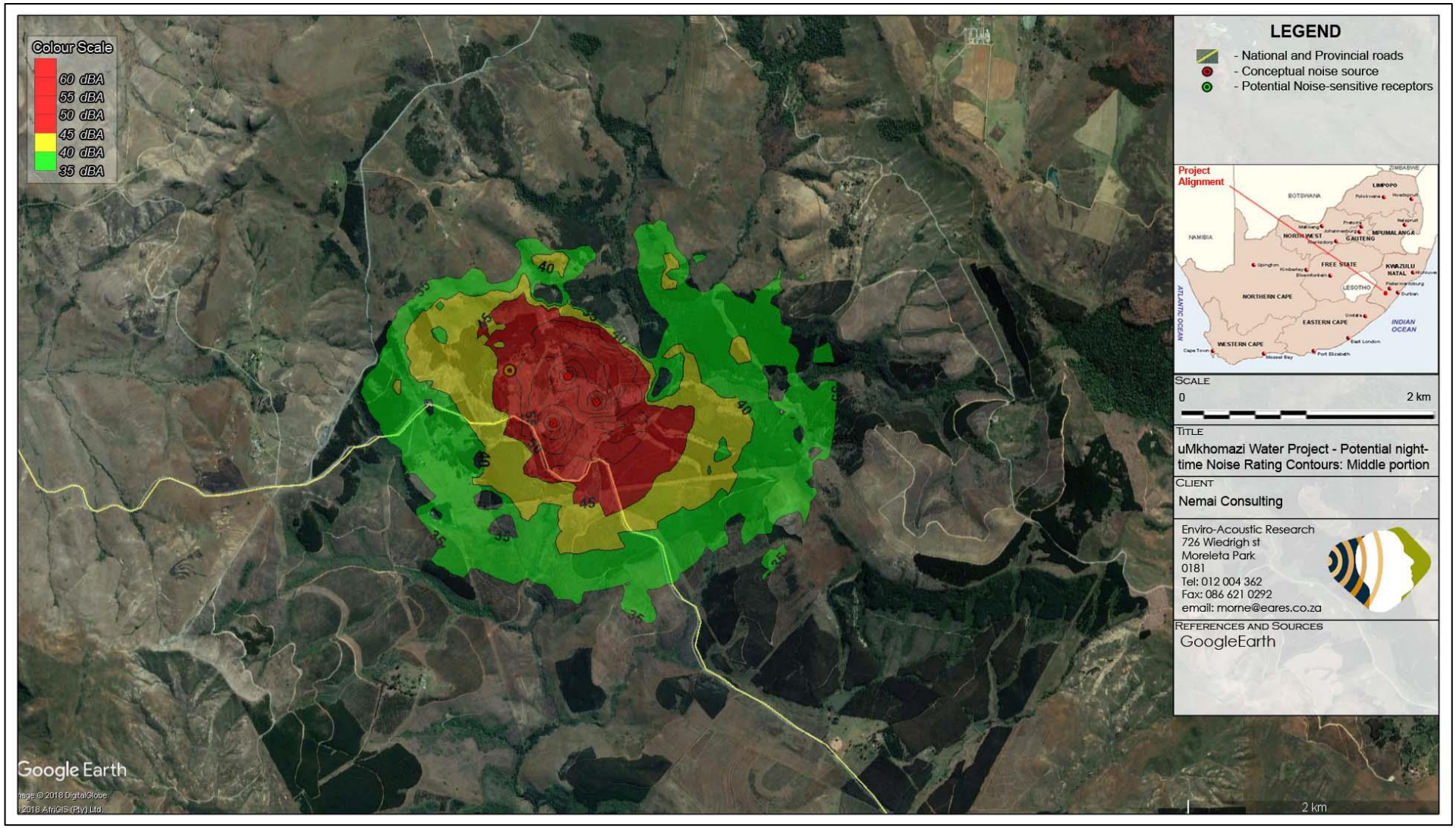

Figure 7-6: Projected conceptual Night-time Construction Activities - Noise Rating Contour Levels (Middle Part of the uMWP-1)

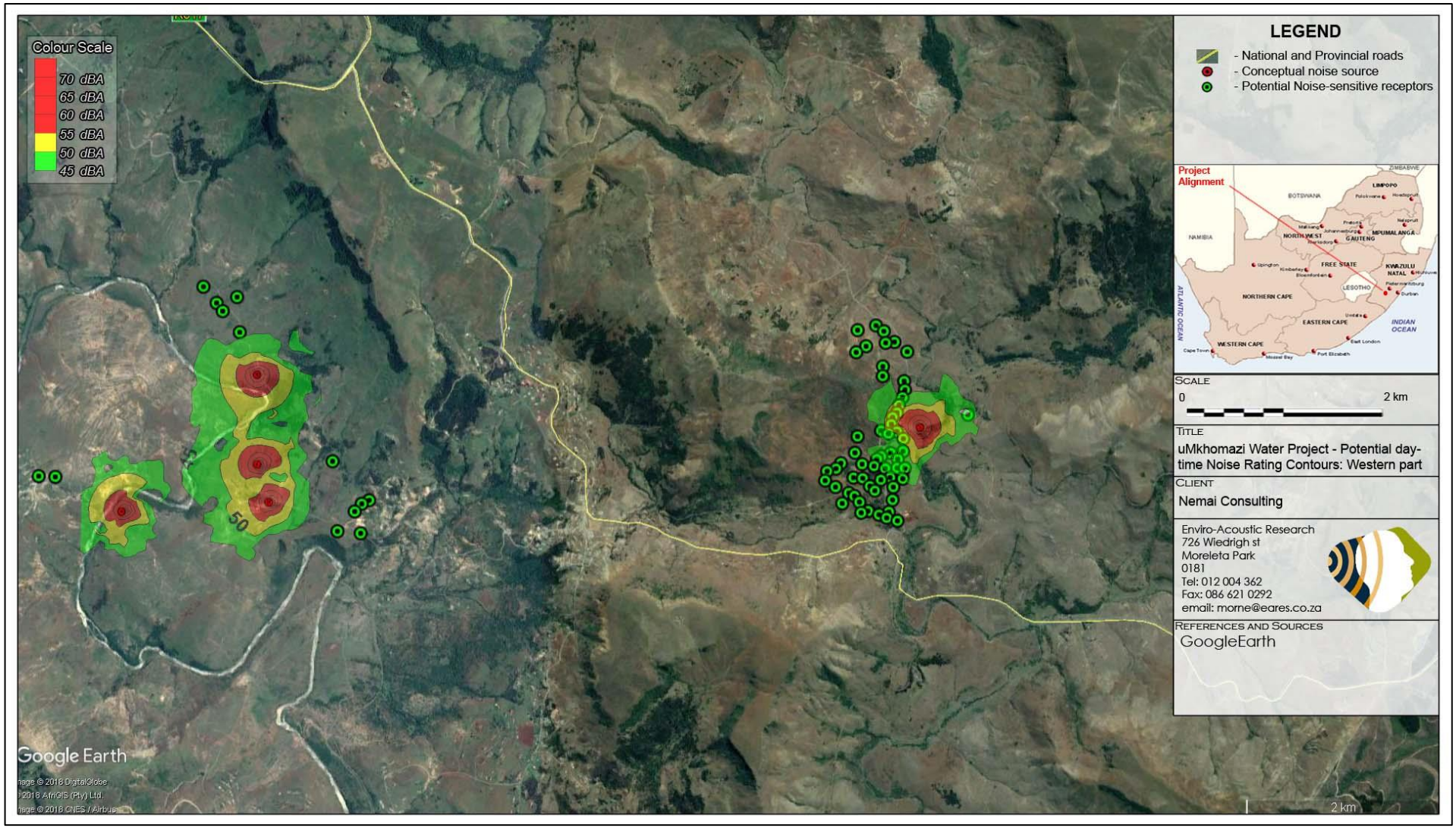

Figure 7-7: Projected Conceptual Daytime Construction Activities - Noise Rating Contour Levels (Western Part of the uMWP-1)

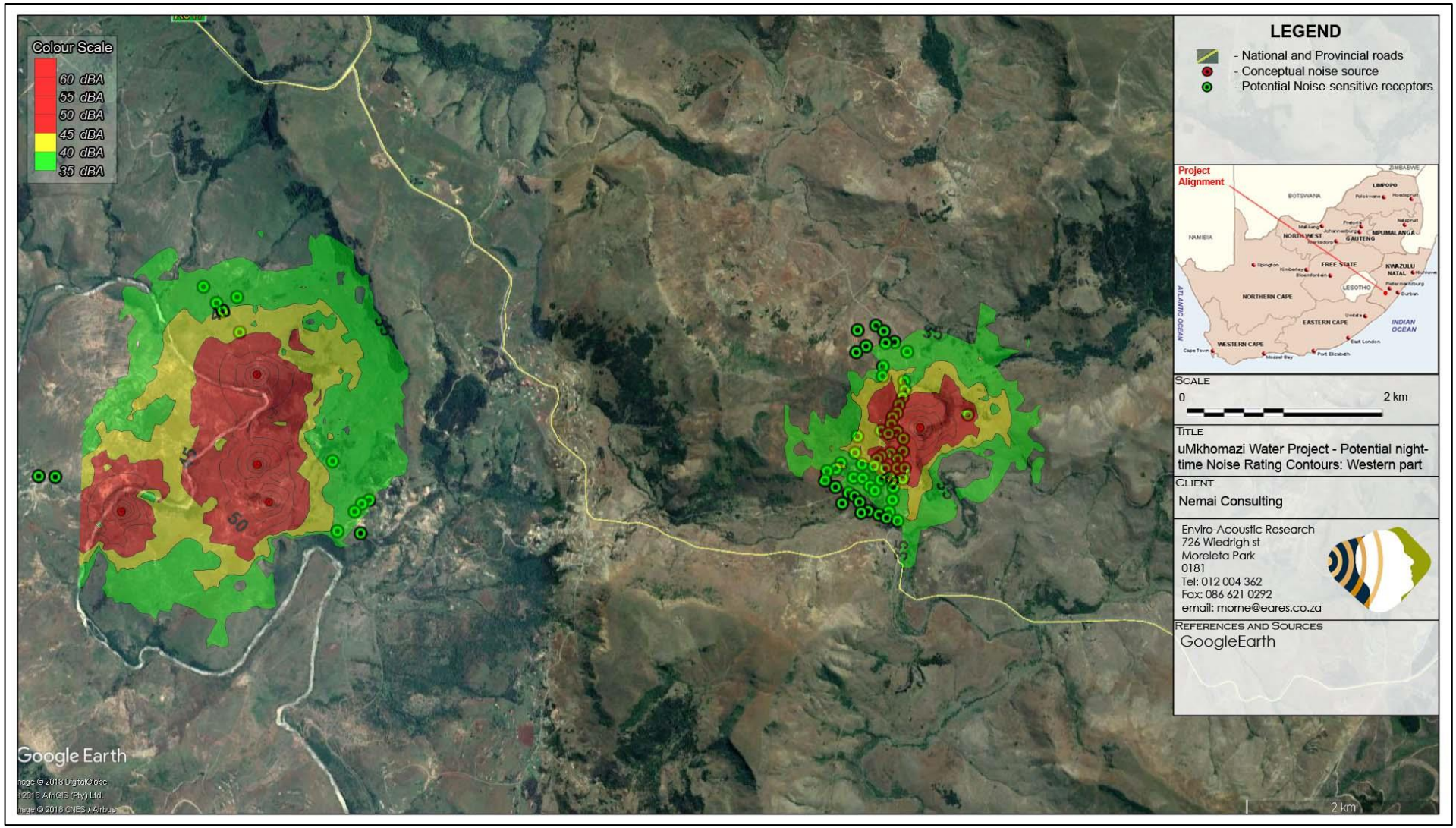

Figure 7-8: Projected Conceptual Night-time Construction Activities - Noise Rating Contour Levels (Western Part of the uMWP-1)

8 SIGNIFICANCE OF THE NOISE IMPACTS

8.1 CONSTRUCTION PHASE NOISE IMPACTS

8.1.1 Potential Noise Impact in the Eastern Section – Avifauna Receptors (Blue Swallows)

The ENIA considers the potential worst-case noise impact, with conceptual noise generating activities taking place close to the potential noise-sensitive receptors as well as the identified breeding areas of the Blue Swallows.

The potential noise-generating construction activities as discussed in section 4.3 and 7.2 was conceptualized and modelled, with the potential daytime and night-time noise rating levels, which are presented in **Figure 7-3** and **Figure 7-4** above. The significance of the potential noise impacts on the Blue Swallows are defined in **Table 8-1** below for the daytime scenario, using the criteria as described in **Paragraph 5.3.4**. The significance of the potential noise impact on Blue Swallows for the night-time scenario is defined in **Table 8-2** below.

Table 8-1: Noise Impact Assessment: Daytime Construction Activities in Eastern Area (Avifauna)

Impacts: Increases in noise levels in the habitat of the Blue Swallows (assuming that the Blue Swallows would detect a change in ambient sound levels of more than 5 dBA – precautionary approach).		
Sensitivity Analysis: Very quiet area with daytime ambient sound levels ($L_{Aeq,i}$) of 30 – 36 dBA and $L_{Aeq,f}$ levels of 25 – 36 dBA. It is assumed that the Blue Swallows would be used to daytime ambient sound of 35 dBA. Noise levels less than 35 dBA would not change the daytime foraging activities. If the Blue Swallows may detect the change in ambient sound levels exceeding 5 dB (40 dBA total), noise levels may impact on less than 7% of their habitat. If this increase in noise level impacts on the foraging activities, the Blue Swallows may avoid the areas where construction activities take place.		
Issue	**Nature of Impact**	**Extent of Impact**
Increase in ambient sound levels at the habitat of the Blue Swallows.	Increased noise levels may impact on ambient sound levels for less than 7% of the Blue Swallows habitat.	Depending on the topography, multiple construction activities taking place simultaneously may impact on the Blue Swallow habitat up to 1,500 m away from the construction activities
Description of Expected Significance of Impact: The probability of a noise impact taking place is **definite** and therefore the Blue Swallows will avoid construction activities during foraging. This may be due to increased noise levels as well as people and vehicular movement. The potential zone of influence is, however, less than 7% of the available habitat area and the potential of noise levels impacting on the foraging activities of the Blue Swallow is considered **improbable** for the larger area. The significance of the noise impact is therefore considered to be **low**.		
Gaps in Knowledge: It is not known what level of noise level will impact on the Blue Swallows. As such this Study took a precautious approach and assumed that a noise level exceeding 40 dBA may affect their foraging activities.		
Comments: High confidence in the assessment.		
Mitigation Measures: Mitigation is not required.		

Table 8-2: Noise Impact Assessment: Night-time Construction Activities in Eastern Area (Avifauna)

Impacts: Increases in noise levels at the nesting sites of the Blue Swallows (assuming that the Blue Swallows would detect a change in ambient sound levels of more than 5 dBA – precautionary approach).		
Sensitivity Analysis: Very quiet area and considering ambient sound levels measured in similar locations at night, ambient sound levels ($L_{Aeq,i}$) could range between 30 – 35 dBA, although these low levels are considered unfeasible[8]. Considering an acceptable ambient sound level of 35 dBA, a change of 5 dB may be detectable and noise levels exceeding 40 dBA may impact on the Blue Swallows nesting sites in the area (very precautious approach). If noise levels are higher than 40 dBA when the Blue Swallows return to select a nesting site, they may select a different nesting site in a quieter area. If noise levels increase higher than 40 dBA the Blue Swallows may abandon their existing nesting sites.		
Issue	**Nature of Impact**	**Extent of Impact**
Increase in ambient sound levels at the Blue Swallows nesting sites.	Increased noise levels may reduce the available nesting sites, or result in the abandonment of existing nesting sites.	Depending on the topography, multiple construction activities taking place simultaneously may impact on the Blue Swallows nesting sites up to 1,500 m away from the construction activities
Description of Expected Significance of Impact: The probability of a noise impact taking place is considered to be **improbable** and the significance of the potential noise impact would be **low** on the Blue Swallows.		
Gaps in Knowledge: Exact construction activities, or their locations, were not defined and this assessment considered a potential worst-case scenario as conceptualized. Various activities can take place during the construction phase and it may be possible that an activity was not considered. It is therefore recommended that no construction activities are permitted within 1,500 m from any active Blue Swallow nesting sites.		
Comments: High confidence in the assessment.		
Mitigation Measures: If viable, it is recommended that no night-time construction activities are permitted within 1,500 m from any active Blue Swallow nesting site.		

8.1.2 Potential Noise Impact in the Eastern Section – Human Receptors

The ENIA considers the potential worst-case noise impact, with conceptual noise generating activities taking place close to the potential noise-sensitive receptors as well as the area identified used by the blue swallows for breeding purposes.

The potential noise-generating construction activities as discussed in the previous section and conceptualized was modelled, with the potential noise rating levels illustrated presented in **Figure** 7-3 (daytime) and **Figure 7-4** (night-time) above. The significance of the potential noise impacts are defined in **Table 8-3** below for the daytime scenario, using the criteria as described in **Paragraph 5.3.4** above.

Table 8-4 below define the significance of the potential noise impact for the night-time scenario.

[8] Blue Swallows would be nesting in an area where there is adequate food. As such it is assumed that there would be significant insects in the area that would raise the night-time noise level.

Table 8-3: Noise Impact Assessment: Daytime Construction Activities in Eastern Area (Humans)

Impacts: Increases in noise levels at the closest receptors (more than 5 dBA – precautionary approach). Noise levels exceeding the SANS 10103 continuous equivalent noise rating level for a rural area.		
Desktop Sensitivity Analysis: Rural area with daytime $L_{R,d}$ rating level of 45 dBA. Daytime ambient sound levels are assumed to be 45 dBA.		
Issue	**Nature of Impact**	**Extent of Impact**
Increase in noise level at receptors which may increase annoyance levels due to the construction activities.	Noise levels would be less than 45 dBA at all NSDs.	Depending on the topography, multiple construction activities taking place simultaneously may impact an area within 600 m from these activities
Description of Expected Significance of Impact: The probability of a noise impact taking place is considered to be **improbable** and the significance of the potential noise impact would be **low** on the NSDs as well as the Blue Swallows.		
Gaps in Knowledge: Construction activities were not defined and this assessment considered a potential worst-case scenario as conceptualized. Various activities can take place during construction and it may be possible that an activity taking place close to a NSD was not considered.		
Comments: High confidence in the assessment.		
Mitigation Measures: Mitigation is not required.		

Table 8-4: Noise Impact Assessment: Night-time Construction Activities in Eastern Area (Humans)

Impacts: Increases in noise levels at the closest receptors (more than 5 dBA). Noise levels exceeding the SANS 10103 continuous equivalent noise rating level for a rural area.		
Desktop Sensitivity Analysis: Rural area with night-time $L_{R,n}$ rating level of 35 dBA. Night-time ambient sound levels are assumed to be 35 dBA at the receptors.		
Issue	**Nature of Impact**	**Extent of Impact**
Increase in noise level at the receptors, which may increase the annoyance due to of the construction activities.	Noise levels would be less than 35 dBA at all NSDs.	Depending on the topography, multiple construction activities taking place simultaneously may impact on an area within 1,000 m from the construction activities (noise levels exceeding 40 dBA).
Description of Expected Significance of Impact: The probability of a noise impact taking place is considered to be **improbable** and the significance of the potential noise impact would be **low** on the NSD.		
Gaps in Knowledge: Construction activities were not defined and this assessment considered a potential worst-case scenario as conceptualized. Various activities can take place during construction and it may be possible that an activity taking place close to a NSD was not considered.		
Comments: High confidence in the assessment.		
Mitigation Measures: Mitigation is not required.		

8.1.3 Potential Noise Impact in the Middle Section – Human Receptors

The potential noise-generating construction activities as discussed in the previous section and conceptualized was modelled, with the potential noise rating levels illustrated presented in **Figure** 7-5 (daytime) and **Figure 7-6** (night-time) above. The significance of the potential noise impacts are defined in **Table 8-5** below for the daytime scenario, using the criteria as described in **Paragraph 5.3.4** above.

Table 8-6 below define the significance of the potential noise impact for the night-time scenario.

Table 8-5: Noise Impact Assessment: Daytime Construction Activities in Middle Section (Humans)

Impacts: Increases in noise levels at the closest receptors (more than 5 dBA). Noise levels exceeding the SANS 10103 continuous equivalent noise rating level for a rural area.		
Desktop Sensitivity Analysis: Rural area with daytime $L_{R,d}$ rating level of 45 dBA. Daytime ambient sound levels are assumed to be 45 dBA.		
Issue	**Nature of Impact**	**Extent of Impact**
Increase in noise level at receptors, which may increase annoyance levels due to the construction activities. Noises exceeding the daytime continuous equivalent noise rating level for a rural area.	Noise levels could range between 45 to 50 dBA at the closest receptor.	Depending on the topography, multiple construction activities taking place simultaneously may impact on an area within 750 m from the construction activities.
Description of Expected Significance of Impact: The probability of a noise impact taking place is considered to be **likely**, but the significance of the potential noise impact would be **low** on the closest receptor.		
Gaps in Knowledge: Construction activities were not defined and this assessment considered a potential worst-case scenario as conceptualized. Various activities can take place during construction and it may be possible that an activity taking place close to a NSD was not considered.		
Comments: High confidence in the assessment.		
Mitigation Measures: Mitigation is not required.		

Table 8-6: Noise Impact Assessment: Night-time Construction Activities in Middle Section (Humans)

Impacts: Increases in noise levels at the closest receptors (more than 5 dBA). Noise levels exceeding the SANS 10103 continuous equivalent noise rating level for a rural area.		
Desktop Sensitivity Analysis: Rural area with night-time $L_{R,n}$ rating level of 35 dBA. Night-time ambient sound levels are assumed to be 35 dBA at closest receptor.		
Issue	**Nature of Impact**	**Extent of Impact**
Increase in noise level at the receptors, which may increase annoyance levels due to construction activities. Potential disturbing noises. Noises exceeding rating level.	Night-time noise levels could range between 45 to 50 dBA at the closest receptor.	Depending on the topography, multiple construction activities taking place simultaneously may impact on an area within 1,900 m from the construction activities.

Description of Expected Significance of Impact: The probability of a noise impact taking place is considered to be **highly likely** and the significance of the potential noise impact would be **medium** on the receptor.
Gaps in Knowledge: Construction activities were not defined and this assessment considered a potential worst-case scenario as conceptualized. Various activities can take place during construction and it may be possible that an activity taking place close to the receptor was not considered.
Comments: High confidence in the assessment.
Mitigation Measures: If the dwellings are used for residential purposes at night, it is proposed that: • A meeting be held with the resident to discuss the projected noise levels as well as to identify viable mitigation measures; • Night-time construction activities be minimised where possible, and if it is required then smallest equipment should be used, as well as • Topsoil can be used to develop a berm between the construction activities and the dwellings, this berm should, however, be constructed during the daytime period.

8.1.4 Potential Noise Impact in the Western Section – Human Receptors

The potential noise-generating construction activities as discussed in the previous section and conceptualized was modelled, with the potential noise rating levels illustrated presented in **Figure** 7-7 (daytime) and **Figure 7-8** (night-time) above. The significance of the potential noise impacts are defined in **Table 8-7** below for the daytime scenario, using the criteria as described in **5.3.4** above. **Table** 8-8 below define the significance of the potential noise impact for the night-time scenario.

Table 8-7: Noise Impact Assessment: Daytime Construction Activities in Western Section (Humans)

Impacts: Increases in noise levels at the closest receptors (more than 5 dBA). Noise levels exceeding the SANS 10103 continuous equivalent noise rating level for a rural area.		
Desktop Sensitivity Analysis: Rural area with daytime $L_{R,d}$ rating level of 45 dBA. Daytime ambient sound levels are assumed to be 45 dBA.		
Issue	**Nature of Impact**	**Extent of Impact**
Increase in noise level at receptors, which may increase annoyance levels due to construction activities. Noises exceeding the daytime continuous equivalent noise rating level for a rural area. Noise levels may be disturbing for the closest receptors living in the Magadini Community.	Noise levels could range between 50 to 55 dBA at the closest receptors in the Magadini Community.	Depending on the topography, multiple construction activities taking place simultaneously may impact on an area within 600 m from the construction activities.
Description of expected significance of impact: The probability of a noise impact taking place is considered to be **likely**, but the significance of the potential noise impact would be **medium** on the closest receptor.		
Gaps in Knowledge: Construction activities were not defined and this assessment considered a potential worst-case scenario as conceptualized. Various activities can take place during construction and it may be possible that an activity taking place close to a NSD was not considered.		
Comments: High confidence in the assessment.		
Mitigation Measures: If the dwellings are used for residential purposes at night, it is proposed that: • A meeting be held with the residents to discuss the projected noise levels, as well as to identify viable mitigation measures. • The number of simultaneous construction activities could be reduced, and equipment with the lowest sound power emission levels should be considered for use. • Topsoil can be used to develop a berm between the construction activities and the dwelling, which should be constructed during the daytime period. • Acoustic screens could be used to reduce acoustic energy.		

Table 8-8: Noise Impact Assessment: Night-time Construction Activities in Western Section (Humans)

Impacts: Increases in noise levels at the closest receptors (more than 5 dBA). Noise levels exceeding the SANS 10103 continuous equivalent noise rating level for a rural area.		
Desktop Sensitivity Analysis: Rural area with a night-time $L_{R,n}$ rating level of 35 dBA. Night-time ambient sound levels are assumed to be 35 dBA at the closest receptor.		
Issue	**Nature of Impact**	**Extent of Impact**
Increase in noise level at the receptors, which may increase annoyance levels due to construction activities. Noises exceeding the night-time continuous equivalent noise rating level for a rural area. Noise levels may be disturbing for the closest receptors living in the Magadini Community.	Night-time noise levels could range between 50 to 55 dBA at the closest receptors in the Magadini Community.	Depending on the topography, multiple construction activities taking place simultaneously may impact an area within 1,200 m from the construction activities.

Description of expected significance of impact: The probability of a noise impact taking place is considered to be **highly likely** and the significance of the potential noise impact would be **medium** on the receptors.
Gaps in Knowledge: Construction activities were not defined and this assessment considered a potential worst-case scenario as conceptualized. Various activities can take place during construction and it may be possible that an activity taking place close to the receptor was not considered.
Comments: High confidence in the assessment.
Mitigation Measures: If the dwellings are used for residential purposes at night, it is proposed that: • A meeting be held with the residents to discuss the projected noise levels, as well as to identify viable mitigation measures. • Night-time construction activities be minimised where possible, and the number of simultaneous construction activities could be reduced. • Equipment with the lowest sound power emission levels should be considered for use during night-time construction activities.. • Topsoil can be used to develop a berm between the construction activities and the dwelling, which should be constructed during the daytime period. • Acoustic screens could be used to reduce acoustic energy.

8.2 OPERATIONAL PHASE NOISE IMPACT

There is a low potential for a noise impact during the operational phase due to the temporary nature of the noises, and therefore the operational noise impacts were not assessed further.

8.3 DECOMMISSIONING AND REHABILITATION PHASE NOISE IMPACT

The noise impact of final decommissioning and rehabilitation activities will be lower than that of the construction activities, since the decommissioning and rehabilitation activities normally take place during the day using minimal equipment. Furthermore, these activities are less urgent in most instances than typical construction activities.

9 MITIGATION OPTIONS

Mitigation can be divided into technical and management options. Technical options may include the use of less noisier equipment and/or the use of berms (acoustical screens) between the noise sources and the receptors. Management options include operating at different times, operating equipment at different locations, as well as limiting the simultaneous use of equipment. Monitoring may be required to measure the success of the mitigation measures. However, even with the best mitigation, it is possible that people may hear the noises from the construction activities at night. Reverse alarms of construction equipment and vehicles, as well as other impulsive sounds do have a nuisance effect and therefore people might complain.

The Implementing Agent (IA) should therefore take note of the following general comments:

1. Good public relations are essential, during stages surrounding human receptors, and other stakeholders, should be informed about the sound generated from the construction activities and thereafter. The information presented to them should be factual, and should not set any unrealistic expectations. It is counterproductive to suggest that the construction activities will be inaudible, or to use vague terms like “quiet”. It is expected that there will be periods when noises will be clearly audible and potentially disturbing. The magnitude of the sound will depend on a multitude of variables and will vary from day to day and from place to place with also taking cognisance of the environmental and operational conditions. Similarly, potential annoyance levels have been linked to visibility and audibility. Audibility is distinct from the sound level, because it depends on the ambient sound level and character, as well as the level and character (spectral, tones and impulsive) of noises generated due to construction and other activities. Psychoacoustics[9] is even more complex, but it has been found that a negative attitude towards a development do influence the possibility of noise complaints.
2. Community involvement needs to be continues throughout the project lifecycle. Annoyance is a complicated psychological phenomenon, as with many industrial operations, expressed annoyance with sound can reflect an overall annoyance with the project, rather than a rational reaction to the sound itself. The uMWP-1, however, offers a benefit to the greater population and region.
3. The IA must implement communication structures, i.e. a help line where complaints could be lodged. All potential human receptors and other stakeholders should be made aware of these communication structures. The IA should also maintain a commitment to the local communities and respond to concerns promptly, since there could be sporadic and legitimate noise complaints, e.g. sudden and sharp increases in sound levels could result from mechanical malfunctions or other unforeseen problems, which can be corrected promptly without unnecessary delays.

[9] Scientific study of sound perception and audiology, specifically, the branch of science studying the psychological and physiological responses associated with sound (including noise, speech and music).

9.1 CONSTRUCTION PHASE

Due to the medium significance for noise impacts on the human receptors, specific mitigation options are required during construction. It is therefore highly recommended that the Contractor include an Environmental Awareness Component in their Safety and Health Induction, which should include a sound and noise facet to create awareness amongst all employees and sub-contractors in terms of the potential noise risks that activities (especially night-time activities) could pose to the surrounding environment.

Further general mitigation measures are highlighted for the IA and Contractor to consider, which could assist to reducing events where increased noises may affect surrounding receptors:

- Convene meetings with the affected communities and other stakeholders to discuss the anticipated noise levels as well as to identify viable mitigation measures.
- Plan for the use the available to construct berms to assist serve as acoustical screens, where possible, between the construction activities and surrounding noise-sensitive receptors to break the line of sight as soon as possible. These berms should ideally be constructed during the daytime using minimal construction equipment. f these berms are correctly constructed, they can significantly reduce the noise impacts on the surrounding receptors.
- The use the smaller and less noisier equipment when operating near receptors;
- Where possible, only operate during daytime.
- During night-time construction activities, the operations should not be closer than 600 m from any receptors in order to prevent noise levels exceeding 45 dBA at the receptors. The specific use of acoustic screens (soil or spoil pile berms or even temporary screens) between receptors and construction activities (receptors closer than 600 m from the construction activities) are recommended to reduce noise levels.
- Ensure that no night-time construction activities take place closer than 1,500 m from any active Blue Swallow nesting sites. If acoustic screens are developed (constructed) between the Blue Swallow nesting sites and the construction activities, then the noise levels will be less, but if night-time activities are planned this must be confirmed with noise measurements or noise propagation modelling.
- Ensure that all equipment is well maintained and fitted with the correct and appropriate noise abatement measures.
- Transporting of equipment and material during daytime periods where possible.

9.2 OPERATIONAL PHASE

There is low risk of a noise impacts during the operational phase, and therefore further mitigation is not required in this regard.

9.3 DECOMMISSIONING AND REHABILITATION PHASE

There is a low risk of a noise impact during the decommissioning and rehabilitation phase, and therefore further mitigation is not required in this regard.

9.4 SPECIAL CONDITIONS

9.4.1 Conditions for Inclusion in the Environmental Authorisation

Conditions that should be included in the Environmental Authorization include the following:

- No night-time construction activities must be permitted closer than 1,500 m to any active Blue Swallow nesting sites;
- The Contractor must investigate any reasonable and valid noise complaint if registered by a receptor residing within 1,000 m from any construction activity, and
- Both the IA and Contractor should be able to indicate that they considered the various mitigation measures proposed in this Report, as well as to give reasons in these mitigation measures could not be implemented, or why they might not be feasible.

9.4.2 Conditions for Inclusion in the Environmental Management Programme

The afore-mentioned aspects for inclusion in the Environmental Authorisation should also be included in the Environmental Management Programme (EMPr) to ensure compliance with the Noise Control Regulations. The aspects to be included in the EMPr are, however, not limited to those required for the Environmental Authorisation and further important aspect could be identified at a later stage as, or if, required.

10 ENVIRONMENTAL NOISE MONITORING PLAN

Environmental Noise Monitoring (ENM) can be divided into two distinct categories, namely:

- Passive monitoring – the registering of any complaints regarding noise, and
- Active monitoring – the measurement of noise levels at identified locations.

As there are a potential for a noise impact, active ENM is recommended. Additional monitoring and noise investigations should be undertaken, if required, when a valid complaint is registered. The Contractor must investigate any such complaints which may include additional noise measurements. Furthermore, it is recommended that the ENM and noise investigations be undertaken by an independent Acoustic Specialist. It should be noted that this Report only highlight areas where noise measurements can be taken, and therefore the exact location must be determined by the Acoustic Consultant onsite when considering the location of construction activities.

10.1 MONITORING LOCALITIES AND PROCEDURES

10.1.1 Monitoring Localities

Daytime measurements (and night-time construction activities are to take place) are recommended at the following locations:

- At the receptor staying just west of the proposed Adit (and spoil sites) – NSD01, see **Figure 10-1** below, and
- At a number of locations in the Magadini Community in the vicinity of the proposed ventilation shaft, see **Figure 10-2** below.

Additional noise measurements should be undertaken at the dwelling/residence of a person who registered a noise complaint, or at locations identified by any other stakeholders. These noise measurements should consider the direct surroundings to ensure that other sound/noise sources cannot influence the readings (or have a minimal influence). A second instrument could also be deployed at the construction activities during these additional noise measurements to assist in confirming that the noise originates from the project site activities.

10.1.2 Monitoring Procedures and Variables to be Analysed

Ambient sound measurements should be collected as defined in SANS 10103:2008. If a safe and secure measurement location can be identified, it is recommended that semi-continuous measurements are taken over a period of at least 16 hours, covering the full daytime period from 06h00 to 22h00. If there are construction activities during night-time, then sound measurements should also be taken during the night-time period from 22h00 – 06h00. Noise measurements should be collected in 10-minute measurements defining the 10-minute descriptors such as $L_{Aeq,I}$ (National Noise Control Regulation Requirement), $L_{A90,f}$ (background noise level as used internationally) and $L_{Aeq,f}$ (Noise level used to compare with IFC noise limit), and these two (2) variables must be analysed.

Furthermore, spectral frequencies should also be measured and analysed to define the potential origins of the noises.

If there is any safety and security concerns exist, then the 10-minute measurements should only be taken during a period when construction activities are taking place, together with notes about the sounds that are heard by the Acoustic Consultant.

If noise measurements are collected in response of a noise complaint, sound level measurements should be collected during the same period, or in conditions similar to when the receptor experienced the disturbing noise event.

10.2 NOISE MONITORING STANDARDS AND TECHNIQUES

Noise measurements must be taken as required by the National Noise Control Regulations (GN R154 of 1992) and SANS 10103:2008.

10.3 MONITORING FREQUENCIES

Quarterly noise monitoring is recommended due to the projected high noise levels, and additional noise measurement locations can be added to based on noise complaints during the previous quarterly monitoring cycle. Measurements can stop if noise monitoring indicates that the noise levels comply with the set standard (40 dBA at night, 50 dBA during the day for a sub-urban noise district).

10.4 DATA CAPTURE PROTOCOLS

Noise measurements must be taken as required by the National Noise Control Regulations (GN R154 of 1992) and SANS 10103:2008. Measurements should be collected in 10-minute bins defining the 10-minute descriptors such as $L_{Aeq,I}$ (National Noise Control Regulation requirement), $L_{A90,f}$ (background noise level as used internationally) and $L_{Aeq,f}$ (Noise level used to compare with IFC noise limit). Spectral frequencies should also be measured to define the potential origin of noise.

10.4.1 Feedback to Receptors and Stakeholders

A Monitoring Report must be compiled considering the requirements of the National Noise Control Regulations (GN R154 of 1992) and SANS 10103:2008. The Project Manager/Team must give feedback to the potential noise-sensitive receptors using the established channels and forums in the area to for allow interaction with the stakeholders. Alternatively a written report can be submitted to the receptor/s (human receptor/s) or other stakeholder/s.

10.4.2 Database Entries and Backups

Data must be store unmodified in the electronic file saved from the instrument. This file can be opened to extract the data to a spread sheet to allow for the processing and illustration (e.g. graphs) thereof. All the data and information should be safeguarded from accidental deletion or corruption.

10.5 STANDARD OPERATING PROCEDURES FOR REGISTERING A COMPLAINT

When a noise complaint is registered, the following information must be obtained:

- Full details of the complainant;
- Date and approximate time when this non-compliance occurred, and
- A description of the noise or event.

Figure 10-1: Possible areas where noise levels could be measured near NSD01

Figure 10-2: Possible areas where noise levels could be measured near Magadini Community

11 RECOMMENDATIONS AND CONCLUSIONS

It is recommended that:

- that the Contractor include an Environmental Awareness Component in their Safety and Health Induction, which should include a sound and noise facet to create awareness amongst all employees and sub-contractors in terms of the potential noise risks that activities (especially night-time activities) could pose to the surrounding environment;
- Convene meetings with the affected communities and other stakeholders to discuss the anticipated noise levels as well as to identify viable mitigation measures;
- Plan for the use the available to construct berms to assist serve as acoustical screens, where possible, between the construction activities and surrounding noise-sensitive receptors to break the line of sight as soon as possible. These berms should ideally be constructed during the daytime using minimal construction equipment. f these berms are correctly constructed, they can significantly reduce the noise impacts on the surrounding receptors;
- The use the smaller and less noisier equipment when operating near receptors;
- Where possible, that construction activities only take place during the daytime when work take place closer than 600 m from potential noise-sensitive receptors;
- During night-time construction activities, the operations should not be closer than 600 m from any receptors in order to prevent noise levels exceeding 45 dBA at the receptors. The specific use of acoustic screens (soil or spoil pile berms or even temporary screens) between receptors and construction activities (receptors closer than 600 m from the construction activities) are recommended to reduce noise levels.
- Ensure that no night-time construction activities take place closer than 1,500 m from any active Blue Swallow nesting sites. If acoustic screens are developed (constructed) between the Blue Swallow nesting sites and the construction activities, then the noise levels will be less, but if night-time activities are planned this must be confirmed with noise measurements or noise propagation modelling.
- Ensure that all equipment is well maintained and fitted with the correct and appropriate noise abatement measures.
- Transporting of equipment and material to take place during daytime periods where possible.

It is concluded that:

- There is a risk of medium significance noise impacts (tunnel adit and western ventilation shafts construction activities), which can be mitigated and reduced with the magnitude of the reduction depending on the selected options (technical and management options

selected to manage noise levels) as well as the way in which construction and other activities are managed, and

- The uMWP-1 will not introduce any potential fatal flaws in terms of acoustics.

With the selection of the required mitigation options, projected noise levels can be managed and Environmental Authorization can be granted.

12 ABOUT THE AUTHOR

The Author started his career in the mining sector as a Bursar Learner Official (JCI, Randfontein), working in the mining industry, doing various mining related courses (Rock Mechanics, Surveying, Sampling, Safety and Health [Ventilation, noise, illumination etc.] and Metallurgy. He did work in both underground (Coal, Gold and Platinum), as well as opencast (Coal) for 4 years. He changed course from Mining Engineering to Chemical Engineering after his second year of his studies at the University of Pretoria.

After graduation he worked as a Water Pollution Control Officer at the Department of Water Affairs and Forestry (DWAF) for two years (first year seconded from Wates, Meiring and Barnard), where his duties included the perusal (evaluation, commenting and recommendation) of various regulatory required documents, such as EMPRs, Water Use Licence Applications (WULAs) and EIAs, auditing of licence conditions as well as the compilation of Technical Documents.

Since leaving the DWAF, Morné has been in private consulting for the last 15 years, managing various projects for the mining and industrial sector, private developers, business, other environmental consulting firms as well as the Department of Water Affairs (DWA). During that period he has been involved in various projects, either as specialist, consultant, trainer or project manager, successfully completing these projects within budget and timeframe. During this period he gradually moved towards environmental acoustics, focusing on this field exclusively since 2007.

He has been interested in acoustics as from school days, doing projects mainly related to loudspeaker design. Interest in the matter brought him into the field of ENM, Prediction and Control. He has been doing work in this field for the past 8 years, and was involved with the following projects in the last few years:

Wind Energy Facilities	*Full Environmental Noise Impact Assessments for - Bannf (Vidigenix), iNCa Gouda (Aurecon SA), Kangnas (Aurecon), Plateau East and West (Aurecon), Wolf (Aurecon), Outeniqwa (Aurecon), Umsinde Emoyeni (ARCUS) , Komsberg (ARCUS), Karee and Kolkies Wind Farms (ARCUS), Canyon Springs (Canyon Springs), Perdekraal (ERM), Zen (Savannah Environmental – SE), Goereesoe (SE), Springfontein (SE), Garob (SE), Project Blue (SE), ESKOM Kleinzee (SE), Walker Bay (SE), Oyster Bay (SE), Hidden Valley (SE), Happy Valley (SE), Deep River (SE), Tsitsikamma (SE), AB (SE), West Coast One (SE), Hopefield II (SE), Namakwa Sands (SE), VentuSA Gouda (SE), Dorper (SE), Amakhala Emoyeni (SE), Klipheuwel (SE), Cookhouse (SE), Cookhouse II (SE), Rheboksfontein (SE), Suurplaat (SE), Karoo Renewables (SE), Koningaas (SE), Eskom Aberdene (SE), Spitskop (SE), Castle (SE), Khai Ma (SE), Poortjies (SE), Korana (SE), IE Moorreesburg (SE), Gunstfontein (SE), Vredenburg (Terramanzi), Loeriesfontein (SiVEST), Rhenosterberg (SiVEST), Noupoort (SiVEST), Prieska (SiVEST), Dwarsrug (SiVEST), Msenge Emoyeni (Windlab), Isivunguvungu Wind Farm (Aurecon), Graskoppies (SiVEST), Hartebeest Leegte (SiVEST), Ithemba (SiVEST), !Xha Boom (SiVEST), Kokerboom 1 (Aurecon), Kokerboom 2 (Aurecon), Teekloof (Mainstream), Sutherland (CSIR), Rietrug (CSIR), Sutherland 2 (CSIR), Spitskop West (Terramanzi)*
Mining and Industry	*Full Environmental Noise Impact Assessments for – Delft Sand (AGES), BECSA – Middelburg (Golder Associates), Kromkrans Colliery (Geovicon Environmental), SASOL Borrow Pits Project (JMA Consulting), Lesego Platinum (AGES), Tweefontein Colliery (Cleanstream Environmental), Evraz Vametco Mine and Plant (JMA), Goedehoop Colliery (Geovicon), Hacra Project (Prescali Environmental), Der Brochen Platinum Project (J9 Environment), Brandbach Sand (AGES), Verkeerdepan Extension*

	(CleanStream Environmental), Dwaalboom Limestone (AGES), Jagdlust Chrome (MENCO), WPB Coal (MENCO), Landau Expansion (CleanStream Environmental), Otjikoto Gold (AurexGold), Klipfontein Colliery (MENCO), Imbabala Coal (MENCO), ATCOM East Expansion (Jones and Wagner), IPP Waterberg Power Station (SE), Kangra Coal (ERM), Schoongesicht (CleanStream Environmental), EastPlats (CleanStream Environmental), Chapudi Coal (Jacana Environmental), Generaal Coal (JE), Mopane Coal (JE), Glencore Boshoek Chrome (JMA), Langpan Chrome (PE), Vlakpoort Chrome (PE), Sekoko Coal (SE), Frankford Power (REMIG), Strahrae Coal (Ferret Mining), Transalloys Power Station (Savannah), Pan Palladum Smelter, Iron and PGM Complex (Prescali Environmental), Fumani Gold (AGES), Leiden Coal (EIMS), Colenso Coal and Power Station (SiVEST/EcoPartners), Klippoortjie Coal (Gudani), Rietspruit Crushers (MENCO), Assen Iron (Tshikovha), Transalloys (SE), ESKOM Ankerlig (SE), Pofadder CSP (SE), Nooitgedacht Titano Project (EcoPartners), Algoa Oil Well (EIMS), Spitskop Chrome (EMAssistance), Vlakfontein South (Gudani), Leandra Coal (Jacana), Grazvalley and Zoetveld (Prescali), Tjate Chrome (Prescali), Langpan Chromite (Prescali), Vereeniging Recycling (Pro Roof), Meyerton Recycling (Pro Roof), Hammanskraal Billeting Plant 1 and 2 (Unica), Development of Altona Furnace, Limpopo Province (Prescali Environmental), Haakdoorndrift Opencast at Amandelbult Platinum (Aurecon), Landau Dragline relocation (Aurecon), Stuart Coal Opencast (CleanStream Environmental), Tetra4 Gas Field Development (EIMS), Kao Diamonds – Tiping Village Relocation (EIMS), Kao Diamonds – West Valley Tailings Deposit (EIMS), Upington Special Economic Zone (EOH), Arcellor Mittal CCGT Project near Saldanha (ERM), Malawi Sugar Mill Project (ERM), Proposed Mooifontein Colliery (Geovicon Environmental), Goedehoop North Residue Deposit Expansion (Geovicon Environmental), Mutsho 600MW Coal-Fired Power Plant (Jacana Environmentals), Tshivhaso Coal-Fired Power Plant (Savannah Environmental), Doornhoek Fluorspar Project (Exigo)
Road and Railway	*The K220 Road Extension (Urbansmart), Boskop Road (MTO), Sekoko Mining (AGES), Davel-Swaziland-Richards Bay Rail Link (Aurecon), Moloto Transport Corridor Status Quo Report and Pre-Feasibility (SiVEST), Postmasburg Housing Development (SE), Tshwane Rapid Transport Project, Phase 1 and 2 (NRM Consulting/City of Tshwane), Transnet Apies-river Bridge Upgrade (Transnet), Gautrain Due-diligence (SiVest), N2 Piet Retief (SANRAL), Atterbury Extension, CoT (Bokomoso Environmental).*
Airports	*Oudtshoorn Noise Monitoring (AGES), Sandton Heliport (Alpine Aviation), Tete Airport Scoping (Aurecon)*
Noise Monitoring and Audit Reports	*Peerboom Colliery (EcoPartners), Thabametsi (Digby Wells), Doxa Deo (Doxa Deo), Harties Dredging (Rand Water), Xstrata Coal – Witbank Regional (Xstrata), Sephaku Delmas (AGES), Amakhala Emoyeni WEF (Windlab Developments), Oyster Bay WEF (Renewable Energy Systems), Tsitsikamma WEF Ambient Sound Level study (Cennergi and SE), Hopefield WEF (Umoya), Wesley WEF (Innowind), Ncora WEF (Innowind), Boschmanspoort (Jones and Wagner), Nqamakwe WEF (Innowind), Hopefield WEF Noise Analysis (Umoya), Dassiesfontein WEF Noise Analysis (BioTherm), Transnet Noise Analysis (Aurecon), Jeffries Bay Wind Farm (Globeleq), Sephaku Aganang (Exigo), Sephaku Delmas (Exigo), Beira Audit (BP/GPT), Nacala Audit (BP/GPT), NATREF (Nemai), Rappa Resources (Rayten), Measurement Report for Sephaku Delmas (Ages), Measurement Report for Sephaku Aganang (Ages), Development noise measurement protocol for Mamba Cement (Exigo), Measurement Report for Mamba Cement (Exigo), Measurement Report for Nokeng Fluorspar (Exigo), Tsitsikamma Community Wind Farm Pre-operation sound measurements (Cennergi), Waainek WEF Operational Noise Measurements (Innowind), Sedibeng Brewery Noise Measurements (MENCO), Tsitsikamma Community Wind Farm Operational noise measurements (Cennergi), Noupoort Wind Farm Operational noise measurements (Mainstream).*
Small Noise Impact Assessments	*TCTA AMD Project Baseline (AECOM), NATREF (Nemai Consulting), Christian Life Church (UrbanSmart), Kosmosdale (UrbanSmart), Louwlardia K220 (UrbanSmart), Richards Bay Port Expansion (AECOM), Babalegi Steel Recycling (AGES), Safika Slag Milling Plant (AGES), Arcelor Mittal WEF (Aurecon), RVM Hydroplant (Aurecon), Grootvlei PS Oil*

	Storage (SiVEST), Rhenosterberg WEF, (SiVEST), Concerto Estate (BPTrust), Ekuseni Youth Centre (MENCO), Kranskop Industrial Park (Cape South Developments), Pretoria Central Mosque (Noman Shaikh), Soshanguve Development (Maluleke Investments), Seshego-D Waste Disposal (Enviroxcellence), Zambesi Safari Equipment (Owner), Noise Annoyance Assessment due to the Operation of the Gautrain (Thornhill and Lakeside Residential Estate), Upington Solar (SE), Ilangalethu Solar (SE), Pofadder Solar (SE), Flagging Trees WEF (SE), Uyekraal WEF (SE), Ruuki Power Station (SE), Richards Bay Port Expansion 2 (AECOM), Babalegi Steel Recycling (AGES), Safika Ladium (AGES), Safika Cement Isando (AGES), RareCo (SE), Struisbaai WEF (SE), Perdekraal WEF (ERM), Kotula Tsatsi Energy (SE), Olievenhoutbosch Township (Nali), , HDMS Project (AECOM), Quarry extensions near Ermelo (Rietspruit Crushers), Proposed uMzimkhulu Landfill in KZN (nZingwe Consultancy), Linksfield Residential Development (Bokomoso Environmental), Rooihuiskraal Ext. Residential Development, CoT (Plandev Town Planners), Floating Power Plant and LNG Import Facility, Richards Bay (ERM), Floating Power Plant project, Saldanha (ERM), Vopak Growth 4 project (ERM), Elandspoort Ext 3 Residential Development (Gibb Engineering).
Project Reviews and Amendment Reports	*Loperberg (Savannah), Dorper (Savannah), Penhoek Pass (Savannah), Oyster Bay (RES), Tsitsikamma Community Wind Farm Noise Simulation project (Cennergi), Amakhala Emoyeni (Windlab), Spreeukloof (Savannah), Spinning Head (SE), Kangra Coal (ERM), West Coast One (Moyeng Energy), Rheboksfontein (Moyeng Energy), De Aar WEF (Holland), Quarterly Measurement Reports – Dangote Delmas (Exigo), Quarterly Measurement Reports – Dangote Lichtenburg (Exigo), Quarterly Measurement Reports – Mamba Cement (Exigo), Quarterly Measurement Reports – Dangote Delmas (Exigo) Quarterly Measurement Reports – Nokeng Fluorspar (Exigo), Proton Energy Limited Nigeria (ERM), Hartebeest WEF Update (Moorreesburg) (Savannah Environmental), Modderfontein WEF Opinion (Terramanzi), IPD Vredenburg WEF (IPD Power Vredenburg).*

13 DECLARATION OF INDEPENDENCE

I, Morné de Jager declare that:

- I act as the Noise 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 undertaking EIAs, including knowledge of the National Environmental Management Act (107 of 1998), the EIA of 2010, and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I will take into account, to the extent possible, the matters listed in regulation 8 of the regulations when preparing the application and any report relating to the application;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I will ensure that information containing all relevant facts in respect of the application is distributed or made available to I&APs and the public and that participation by I&APs is facilitated in such a manner that all I&APs will be provided with a reasonable opportunity to participate and to provide comments on documents that are produced to support the application;
- I will ensure that the comments of all I&APs are considered and recorded in reports that are submitted to the competent authority in respect of the application, provided that comments that are made by I&APs in respect of a final report that will be submitted to the competent authority may be attached to the report without further amendment to the report;
- I will keep a register of all I&APs that participated in a Public Participation Process (PPP);
- I will provide the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not;
- All the particulars furnished by me in this form are true and correct;
- I will perform all other obligations as expected from an Environmental Assessment Practitioner (EAP) in terms of the Regulations, and
- I realise that a false declaration is an offence in terms of regulation 71 and is punishable in terms of Section 24F of the Act. (The National Environmental Management Act - Act 107 of 1998).

Disclosure of Vested Interest

- I do not have and will not have any vested interest (either business, financial, personal or other) in the proposed activity proceeding other than remuneration for work performed in terms of the EIA Regulations, 2010.

Signature of the Specialist:

Enviro-Acoustic Research cc
Name of company:

30 May 2018
Date:

14 REFERENCES

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APPENDIX A

Glossary of Acoustic Terms, Definitions and General Information

1/3-Octave Band	A filter with a bandwidth of one-third of an octave representing four semitones, or notes on the musical scale. This relationship is applied to both the width of the band, and the centre frequency of the band. See also definition of octave band below.
A – Weighting	An internationally standardised frequency weighting that approximates the frequency response of the human ear and gives an objective reading that therefore agrees with the subjective human response to that sound.
Air Absorption	The phenomena of attenuation of sound waves with distance propagated in air, due to dissipative interaction within the gas molecules.
Alternatives	A possible course of action, in place of another, that would meet the same purpose and need (of proposal). Alternatives can refer to any of the following, but are not limited hereto: Alternative sites for development, alternative site layouts, alternative designs, alternative processes and materials. In Integrated Environmental Management the so-called "no go" alternative refers to the option of not allowing the development and may also require investigation in certain circumstances.
Ambient	The conditions surrounding an organism or area.
Ambient Noise	The all-encompassing sound at a point being composed of sounds from many sources both near and far. It includes the noise from the noise source under investigation.
Ambient Sound	The all-encompassing sound at a point being composite of sounds from near and far.
Ambient Sound Level	Means the reading on an integrating impulse sound level meter taken at a measuring point in the absence of any alleged disturbing noise at the end of a total period of at least 10 minutes after such a meter was put into operation. In this Report the term Background Ambient Sound Level will be used.
Amplitude Modulated Sound	A sound that noticeably fluctuates in loudness over time.
Applicant	Any person who applies for an authorisation to undertake a listed activity or to cause such activity in terms of the relevant environmental legislation.
Assessment	The process of collecting, organising, analysing, interpreting and communicating data that is relevant to some decision.
Attenuation	Term used to indicate reduction of noise or vibration, by whatever method necessary, usually expressed in decibels.
Audible frequency Range	Generally assumed to be the range from about 20 Hz to 20,000 Hz, the range of frequencies that our ears perceive as sound.
Ambient Sound Level	The level of the ambient sound indicated on a sound level meter in the absence of the sound under investigation (e.g. sound from a particular noise source or sound generated for test purposes). Ambient sound level as per Noise Control Regulations.
Broadband Noise	Spectrum consisting of a large number of frequency components, none of which is individually dominant.
C-Weighting	This is an international standard filter, which can be applied to a pressure signal or to a Sound Pressure Level (SPL) or Sound Power Level (PWL) spectrum, and which is essentially a pass-band filter in the frequency range of approximately 63 to 4000 Hz. This filter provides a more constant, flatter, frequency response, providing significantly less adjustment than the A-scale filter for frequencies less than 1000 Hz.
Controlled Area (as per National Noise Control Regulations)	A piece of land designated by a local authority where, in the case of- (a) road transport noise in the vicinity of a road- (i) the reading on an integrating impulse sound level meter, taken outdoors at the end of a period extending from 06:00 to 24:00 while such a meter is in operation, exceeds 65 dBA, or (ii) the equivalent continuous "A"-weighted sound pressure level at a height of at least 1,2 m, but not more than 1,4 m, above the ground for a period extending from 06:00 to 24:00 as calculated in accordance with SABS 0210-1986, titled: "Code of Practice for calculating and predicting road traffic noise",

	published under Government Notice No. 358 of 20 February 1987, and projected for a period of 15 years following the date on which the local authority has made such designation, exceeds 65 dBA; (b) aircraft noise in the vicinity of an airfield, the calculated noisiness index, projected for a period of 15 years following the date on which the local authority has made such designation, exceeds 65 dBA; or (c) industrial noise in the vicinity of an industry- (i) the reading on an integrating impulse sound level meter, taken outdoors at the end of a period of 24 hours while such meter is in operation, exceeds 61 dBA; or (ii) the calculated outdoor equivalent continuous "A"-weighted sound pressure level at a height of at least 1,2 m, but not more than 1,4 m, above the ground for a period of 24 hours, exceeds 61 dBA;
dBA	Sound Pressure Level in decibel that has been A-weighted, or filtered, to match the response of the human ear.
Decibel (dB)	A logarithmic scale for sound corresponding to a multiple of 10 of the threshold of hearing. Decibels for sound levels in air are referenced to an atmospheric pressure of 20 µ Pa.
Diffraction	The process whereby an acoustic wave is disturbed and its energy redistributed in space as a result of an obstacle in its path, Reflection and refraction are special cases of diffraction.
Direction of Propagation	The direction of flow of energy associated with a wave.
Disturbing Noise	Means a noise level that exceeds the zone sound level or, if no zone sound level has been designated, a noise level that exceeds the ambient sound level at the same measuring point by 7 dBA or more.
Environment	The external circumstances, conditions and objects that affect the existence and development of an individual, organism or group; these circumstances include biophysical, social, economic, historical, cultural and political aspects.
Environmental Control Officer (ECO)	An Independent Officer employed by the applicant to ensure the implementation of the Environmental Management Plan (EMP) and manages any further environmental issues that may arise.
Environmental Impact	A change resulting from the effect of an activity on the environment, whether desirable or undesirable. Impacts may be the direct consequence of an organisation's activities or may be indirectly caused by them.
Environmental Impact Assessment (EIA)	An EIA refers to the process of identifying, predicting and assessing the potential positive and negative social, economic and biophysical impacts of any proposed project, plan, programme or policy that requires authorisation of permission by law and that may significantly affect the environment. The EIA includes an evaluation of alternatives, as well as recommendations for appropriate mitigation measures for minimising or avoiding negative impacts, measures for enhancing the positive aspects of the proposal, as well as environmental management and monitoring measures.
Environmental Issue	A concern felt by one or more parties about some existing, potential or perceived environmental impact.
Equivalent continuous A-weighted sound exposure level ($L_{Aeq,T}$)	The value of the average A-weighted sound pressure level measured continuously within a reference time interval *T*, which have the same mean-square sound pressure as a sound under consideration for which the level varies with time.
Equivalent	The equivalent continuous A-weighted sound exposure level *($L_{Aeq,T}$)* to which various

continuous A-weighted rating level ($L_{Req,T}$)	adjustments has been added. More commonly used as ($L_{Req,d}$) over a time interval (daytime) from 06h00 to 22h00 (T=16 hours) and ($L_{Req,n}$) over a time interval (night-time) from 22h00 to 06h00 (T=8 hours). These are calculated values.
F (fast) time weighting	(1) Averaging detection time used in sound level meters. (2) Fast setting has a time constant of 125 milliseconds and provides a fast reacting display response allowing the user to follow and measure not too rapidly fluctuating sound.
Footprint Area	Area to be used for the construction of the proposed development, which does not include the total study area.
Free Field Condition	An environment where there is no reflective surfaces.
Frequency	The rate of oscillation of a sound, measured in units of Hz or kHz. One hundred Hz is a rate of one hundred times per second. The frequency of a sound is the property perceived as pitch, which is a low-frequency sound (such as a bass note) oscillates at a relatively slow rate, and a high-frequency sound (such as a treble note) oscillates at a relatively high rate.
Greenfield	A parcel of land not previously developed beyond that of agriculture or forestry use; virgin land. The opposite of Greenfield is Brownfield, which is a site previously developed and used by an enterprise, especially for a manufacturing or processing operation. The term Brownfield suggests that an investigation should be made to determine if environmental damage exists.
G-Weighting	An International Standard filter used to represent the infrasonic components of a sound spectrum.
Harmonics	Any of a series of musical tones for which the frequencies are integral multiples of the frequency of a fundamental tone.
I (impulse) time weighting	(1) Averaging detection time used in sound level meters as per South African Standards and Regulations. (2) Impulse setting has a time constant of 35 milliseconds when the signal is increasing (sound pressure level rising) and a time constant of 1,500 milliseconds while the signal is decreasing.
Impulsive Sound	A sound characterized by brief excursions of sound pressure (transient signal) that significantly exceed the ambient sound level.
Infrasound	Sound with a frequency content below the threshold of hearing, generally held to be about 20 Hz. Infrasonic sound with sufficiently large amplitude can be perceived, and is both heard and felt as vibration. Natural sources of infrasound are waves, thunder and wind.
Interested and Affected Parties (I&APs)	Individuals or groups concerned with or affected by an activity and its consequences. These include the authorities, local communities, investors, work force, consumers, environmental interest groups and the general public.
Key Issue	An issue raised during the Scoping Process that has not received an adequate response and that requires further investigation before it can be resolved.
L_{A90}	The sound level exceeded for the 90% of the time under consideration
Listed Activities	Development actions that is likely to result in significant environmental impacts as identified by the delegated authority (formerly the Minister of Environmental Affairs and Tourism) in terms of Section 21 of the Environment Conservation Act.
L_{AMin} *and* L_{AMax}	Is the Root Mean Squared (RMS) minimum or maximum level of a noise source.
Loudness	The attribute of an auditory sensation that describes the listener's ranking of sound in terms of its audibility.
Magnitude of Impact	The combination of the intensity, duration and extent of an impact occurring.
Masking	The raising of a listener's threshold of hearing for a given sound due to the presence of

	another sound.
Mitigation	To cause to become less harsh or hostile.
Negative Impact	A change that reduces the quality of the environment (for example, by reducing species diversity and the reproductive capacity of the ecosystem, by damaging health, or by causing nuisance).
Noise	a) A sound that a listener does not wish to hear (unwanted sounds). b) A sound from sources other than the one emitting the sound it is desired to receive, measure or record. c) A class of sound of an erratic, intermittent or statistically random nature.
Noise Level	The term used in lieu of sound level when the sound concerned is being measured or ranked for its undesirability in the contextual circumstances.
Noise-sensitive Development (NSD)	Developments that could be influenced by noise such as: a) districts (see Table 2 of SANS 10103:2008) 1. rural districts, 2. suburban districts with little road traffic, 3. urban districts, 4. urban districts with some workshops, with business premises, and with main roads, 5. central business districts, and 6. industrial districts; b) educational, residential, office and health care buildings and their surroundings; c) churches and their surroundings; d) auditoriums and concert halls and their surroundings; e) recreational areas, and f) nature reserves. In this Report NSDs are also referred to as a Potential Noise-sensitive Receptor
Octave Band	A filter with a bandwidth of one octave, or twelve (12) semi-tones on the musical scale representing a doubling of frequency.
Positive Impact	A change that improves the quality of life of affected people or the quality of the environment.
Property	Any piece of land indicated on a diagram or general plan approved by the Surveyor-General intended for registration as a separate unit in terms of the Deeds Registries Act and includes an erf, a site and a farm portion as well as the buildings erected thereon.
Public Participation Process (PPP)	A process of involving the public in order to identify needs, address concerns, choose options, plan and monitor in terms of a proposed project, programme or development
Reflection	Redirection of sound waves.
Refraction	Change in direction of sound waves caused by changes in the sound wave velocity, typically when sound wave propagates in a medium of different density.
Reverberant Sound	The sound in an enclosure which results from repeated reflections from the boundaries.
Reverberation	The persistence, after emission of a sound has stopped, of a sound field within an enclosure.
Significant Impact	An impact can be deemed significant if consultation with the relevant authorities and other interested and affected parties, on the context and intensity of its effects, provides reasonable grounds for mitigating measures to be included in the environmental management report. The onus will be on the applicant to include the relevant authorities and other interested and affected parties in the consultation process. Present and potential future, cumulative and synergistic effects should all be taken into account.
S (slow) time weighting	(1) Averaging times used in sound level meters. (2) Time constant of one [1] second that gives a slower response which helps average

	out the display fluctuations.
Sound Level	The level of the frequency and time weighted sound pressure as determined by a sound level meter, i.e. A-weighted sound level.
Sound Power	Of a source, the total sound energy radiated per unit time.
Sound Pressure Level (SPL)	Of a sound, 20 times the logarithm to the base 10 of the ratio of the RMS sound pressure level to the reference sound pressure level. International values for the reference sound pressure level are 20 micropascals in air and 100 millipascals in water. The SPL is reported as L_p in dB (not weighted) or in various other weightings.
Soundscape	Sound or a combination of sounds that forms or arises from an immersive environment. The study of soundscape is the subject of acoustic ecology. The idea of soundscape refers to both the natural acoustic environment, consisting of natural sounds, including animal vocalizations and, for instance, the sounds of weather and other natural elements; and environmental sounds created by humans, through musical composition, sound design, and other ordinary human activities including conversation, work, and sounds of mechanical origin resulting from use of industrial technology. The disruption of these acoustic environments results in noise pollution.
Study Area	Refers to the entire study area encompassing all the alternative routes as indicated on the Study Area Map.
Sustainable Development	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: the concept of "needs", in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and the future needs (Brundtland Commission, 1987).
Tread Braked	The traditional form of wheel brake consisting of a block of friction material (which could be cast iron, wood or nowadays a composition material) hung from a lever and being pressed against the wheel tread by air pressure (in the air brake) or atmospheric pressure in the case of the vacuum brake.
Zone of Potential Influence	The area defined as the radius about an object, or objects beyond which the noise impact will be insignificant.
Zone Sound Level	Means a derived dBA value determined indirectly by means of a series of measurements, calculations or table readings and designated by a local authority for an area. This is similar to the Rating Level as defined in SANS 10103:2008.

APPENDIX B

Site Investigation – Photos of Measurement Locations

Photo B.1: Measurement Location UWASLST01

Photo B.2: Measurement Location UWASLST03

Photo B.3: Measurement Location UWASLST04

Photo B.4: Measurement Location UWASLST05

Photo B.5: Measurement Location UWASLST06

Photo B.6: Measurement Location UWASLST07

Photo B.7: Measurement Location UWASLST08

Photo B.8: Measurement Location UWASLST09

Photo B.9: Measurement Location UWASLST10

Photo B.10: Measurement Location UWASLST12