FE Bonne Esperance (Pty) Ltd

COMPARATIVE NOISE IMPACT ASSESSMENT

for the

Establishment of the Zen Wind Energy Facility near the town of Saron, Western Cape

Study done for:

savannah environmental

Prepared by:

EAR Enviro Acoustic Research

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EXECUTIVE SUMMARY

INTRODUCTION AND PURPOSE

M2 Environmental Connections cc conducted an Environmental Noise Impact Assessment (ENIA) during end 2012 (report ZT-ZWEF/ENIA/201211-Rev 0) for the proposed Zen Wind Energy Facility (WEF). Since the date of the initial study, the project has been reviewed a number of times, including:

- an addendum report in 2013 (SE-ZWEF/ENIA/201311-Rev 1);
- a review report in 2017 (ZT-ZWEF/ENIA/201707-Rev 0); and
- a review report in 2018 (ZT-ZWEF/ENIA/201808-Rev 0).

The developer is proposing a number of changes to the Zen Wind Energy Facility (WEF) and it was requested to review the potential change in the noise impact and whether it would result in a change in the findings and recommendations of the previous ENIA. Enviro-Acoustic Research (EARES) was consequently contracted by Savannah Environmental (Pty) Ltd (the EAP) to do a comparative noise assessment on the surrounding environment due to the proposed amendments to the turbine specifications of the Zen WEF.

This comparative assessment should be read in conjunction with reports ZT-ZWEF/ENIA/201211-Rev 0 (dated November 2011) and SE-ZWEF/ENIA/201311-Rev 1 (dated November 2013) for this project, defining the ambient sound levels in the area.

PROJECT DESCRIPTION

ZEN Wind Farm (Pty) Ltd (now FE Bonne Esperance (Pty) Ltd) which received EA on 03 November 2016 (as subsequently amended on 11 February 2019) is proposing the following amendments for the ZEN
Wind Energy Facility.

- Reduction in the number of turbines from **46** to **27**;
- Increase in the overall capacity of the wind energy facility from **140 MW** to up to **147 MW**;
- Amendment of turbine specifications as follows:
    - Increase rated power of turbines from **3 MW** to up to **6 MW per WTG**;
    - Increase Hub Height from **110 m** to **up to 140 m**;
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- Potential increase to dimensions of the crane pad and laydown area (storage area per turbine);
- Increase in the concrete foundation from **20m x 20m x 4m** to **25m x 25m x 6m**;
- Update of the **layout;** and

- Change the **holder of the EA** (from ***ZEN Wind Farm (Pty) Ltd*** to ***FE Bonne Esperance (Pty) Ltd***).

The amendment of turbine specifications and change to the layout constitutes as a Part 2 amendment application as contemplated in Regulation 31 of the 2014 EIA Regulations, as amended.

For the purpose of this noise assessment the sound power emission levels of the GE 3.6-137 wind turbine was used. The 2013 noise study made use of the sound power emission levels of the ECO 110 wind turbine.

BASELINE ASSESSMENT

During the EIA process undertaken for the Zen Wind Energy Facility (WEF), ambient sound levels were measured at two (2) locations over a period of at least two (2) night-time periods. Sound measurements indicated an area with a relative high ambient sound level, mainly due to wind-induced noises.

While the area had a rural character in terms of development, ambient sound levels were significantly higher than a rural noise district, with ambient sound levels leaning towards a busy commercial noise district. It was likely that the ambient sound levels would be typical of a rural noise district during periods of low or no winds, although this was not observed (or measured) during the site visit.

NOISE IMPACT FINDINGS

This comparative study used the noise emission characteristics of the GE 3.6-137 wind turbine. Various construction activities would be taking place during the development of the facility and may pose a noise risk to the closest receptors. The resulting future noise projections indicated that the construction activities of the wind turbines, as modelled for the conceptual scenario, will comply with the provincial Noise Control Regulations for construction activities.

The previous Environmental Noise Impact Assessment determined a noise impact of low significance during the construction phase (report ZT-ZWEF/ENIA/201211-Rev 0). Based on the changes in the new layout and wind turbine specifications, the magnitude of the noise levels as well as the probability of a noise impact occurring will be similar.

RECOMMENDATIONS AND CONCLUSIONS

The potential noise impact must be re-evaluated should the layout be changed where any wind turbines are located closer than 1,000 m from a confirmed NSD, or if the developer decides to use a different wind turbine with a sound power emission level higher than the GE 3.6-137 wind turbine used in this report (sound power emission level exceeding 107 dBA re 1 pW).

Considering the modelled construction and operational noise levels, the proposed changes to the layout and wind turbines specifications will not lead to any other noise impacts, neither will it change the significance of the noise impact as defined in the original reports. The findings and recommendations highlighted in the original 2012 and 2013 amendment would remain.

Considering the possible **low** significance of the noise impacts there is no reason that the proposed amendment of the Zen WEF cannot be authorised.

This report should be sited as:

De Jager, M. (2019): "Comparative *Noise Impact Assessment for the Establishment of the Zen Wind Energy Facility near the town of Saron, Western Cape*". Enviro-Acoustic Research CC, Pretoria

Client:

Savannah Environmental (Pty) Ltd for
Zen Wind Farm (Pty) Ltd

PO BOX 148
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Report no:

ZT-ZWEF/ENIA/201910-Rev 0

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Date:

October 2019

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GLOSSARY OF ABBREVIATIONS

DEA	Department of Environmental Affairs
DoE	Department of Energy
EA	Environmental Authorisation
EARES	Enviro Acoustic Research cc
FEL	Front end loader
hh	Hub height
i.e.	that is
i.t.o	In terms of
IFC	International Finance Corporation
km	kilometres (measurement of distance)
LDV	Light delivery vehicle
m	meters (measurement of distance)
mamsl	Meters above mean sea level
m/s	meters per second
MW	Megawatt
NEMA	National Environmental Management Act, 1998 (Act 107 of 1998)
NCR	Noise Control Regulations (under Section 25 of the ECA)
PPA	Power Purchase Agreement
SANS	South African National Standards (from South African Bureau of Standards)
TLB	Tip load bucket (also called a Bucket loader)
ToR	Terms of Reference
UTM	Universal Transverse Mercator
WHO	World Health Organisation
WEF	Wind Energy Facility
WTG	Wind Turbine Generators

1 THE AUTHOR

The Author started his career in the mining industry 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 for two years (first year seconded from Wates, Meiring and Barnard), where duties included the perusal (evaluation, commenting and recommendation) of various regulatory required documents (such as EMPR's, Water Licence Applications and EIA's), auditing of licence conditions as well as the compilation of Technical Documents.

Since leaving the Department of Water Affairs, 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. 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 that 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 Environmental Noise Measurement, Prediction and Control. He has been doing work in this field for the past 12 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	*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)*
Airport	*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)*

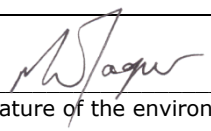
2 DECLARATION OF INDEPENDENCE

I, Morné de Jager declare that:

- I act as the independent environmental practitioner in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting environmental impact assessments, including knowledge of the National Environmental Management Act (107 of 1998), the Environmental Impact Assessment Regulations 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 interested and affected parties and the public and that participation by interested and affected parties is facilitated in such a manner that all interested and affected parties 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 interested and affected parties 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 interested and affected parties 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 interested and affected parties that participated in a public participation process; and
- 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;
- will perform all other obligations as expected from an environmental assessment practitioner 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.

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 Environmental Impact Assessment Regulations, 2010.



Signature of the environmental practitioner:

Enviro-Acoustic Research cc
Name of company:

19 October 2019
Date:

3 INTRODUCTION

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For the purpose of this noise assessment the sound power emission levels of the GE 3.6-137 wind turbine was used. The 2013 noise study made use of the sound power emission levels of the ECO 110 wind turbine.

3.3 STUDY AREA

The study area falls within the Drakenstein Local Municipal area. The study area is further described in terms of environmental components that may contribute to or change the sound character in the area.

3.3.1 Topography

The WEF is proposed to be developed on a relatively flat topography. The western side can be defined as moderately undulating plains with the eastern side being high mountains (Obiekwaberg and Oukloofberg mountains).

3.3.2 Roads and rail roads

The only paved road in the study area is the R44 Road. Other smaller un-paved roads traverse the area but traffic on them is considered to be insignificant. There is a railway line that traverse portion 1 of the farm Bonne Esperance 83. Road traffic, while audible closer to the road, does not impact significantly on the ambient sound levels in the area (may only affect the area within 100m of the road). As the night-time sound environment is of particular concern, road traffic noises will not be considered in this report.

3.3.3 Land use

The eastern portion of the study area is natural and the land use is wilderness. Significant agricultural activities can be observed in the centre and western portions of the study area (dryland wheat and citrus orchards). As the night-time noise environment is of particular

interest in this document, current land use activities are not expected to impact much on the ambient sound environment.

3.3.4 Residential areas

Excluding potentially noise-sensitive developments identified in **Section 3.3.7**, the closest community is the town of Saron approximately 5 km north of the closest wind turbine of the proposed WEF. It is highly unlikely that the town would be impacted by increased noise levels due to the operation of the proposed facility.

3.3.5 Other industrial and commercial processes

With the night-time soundscape being the environmental aspect of concern, the only other facility that may cumulative impact on the soundscape is the Gouda Wind Farm, located south-east of the proposed Zen WEF.

3.3.6 Ground conditions and vegetation

Most of the area falls within the Cape Floristic region with the Fynbos biome dominant. The western areas can be classified as the coastal renosterbosveld, with the eastern side in the more mountainous areas being fynbos. Aerial images shows the area to be well vegetated, but as typical with dryland agriculture, dryland fields could be bare for a certain time of the year.

3.3.7 Existing Ambient Sound Levels

Ambient sound levels were measured at two locations over 35 hours from the afternoon of the 14th till the morning of the 16 October 2012. The data indicate an area where ambient sound levels are elevated, mainly due to natural sound sources relating to bird communication as well as wind induced noises. The data show that ambient sound levels do increase as wind speeds increase. Sound levels ranging between 45 and 60 dBA are expected during periods when the WEF may be operational.

3.4 POTENTIAL NOISE-SENSITIVE RECEPTORS (DEVELOPMENTS) AND NO-GO AREAS

Potentially sensitive receptors, also known as noise-sensitive developments (NSD's), located within or close to the WEF were identified during the EIA process using Google Earth® (green dots, see **Figure 3-1**).

3.5 TERMS OF REFERENCE (TOR)

This comparative noise impact study assesses:

- The noise impacts related to the proposed changes;
- Advantages and/or disadvantages associated with the changes;
- Comparative assessment of the impacts before and after the changes; and
- Measures to ensure avoidance, management and mitigation of impacts associated with such proposed changes as well as any changes to the EMPr.

The comparative noise impact assessment must be clear on whether the proposed changes to the EA will:

- Increase the significance of impacts originally identified in the EIA report or lead to any additional impacts; or
- Have a zero or negligible effect on the significance of impacts identified in the EIA report; or
- Lead to a reduction in any of the identified impacts in the EIA report.

Figure 3-1: Aerial image indicating potentially noise-sensitive developments (green dots) identified during the EIA process

4 CURRENT ENVIRONMENTAL SOUND CHARACTER

4.1 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 **section 4.2**).

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 the following sections.

4.1.1 Effect of wind on sound propagation

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 3 – 5 m/s.

4.1.2 Effect of temperature on sound propagation

On a typical sunny afternoon, air is warmest near the ground 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 toward 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 would decrease the sound level at a listener 600 m away by 3 dB (at 1,000 Hz).

4.1.3 Effect of humidity on sound propagation

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).

4.2 EFFECT OF WIND SPEEDS 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

speeds 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.

4.3 INFLUENCE OF WIND ON NOISE LIMITS

Current local regulations and standards do not consider changing ambient (background) sound levels due to natural events such as can be found near the coast or areas where wind-induced noises are prevalent. This is unfeasible with wind energy facilities as these facilities will only operate when the wind is blowing. It is therefore important that the contribution of wind-induced noises be considered when determining the potential noise impact from such as a facility. Care should be taken when taking this approach due to other factors that complicate noise propagation from wind turbines.

While the total ambient sound levels are of importance, the spectral characteristics also determine the likelihood that someone will hear external noises that may or may not be similar in spectral characteristics to that of the vegetation that created the noise. Bolin (2006) did investigate spectral characteristics and determined that annoyance might occur at levels where noise generated by wind turbine noise exceeds natural ambient sounds with 3 dB or more.

Low frequency noises can also be associated with some wind turbines. Separating the potential low frequency noise from wind turbines from that generated by natural sources as well as other anthropogenic sources can and will be a challenge.

There are a number of factors that determine how ambient sound levels close to a dwelling (or the low-frequency noise levels inside the house) might differ from the ambient sound levels further away (or even at another dwelling in the area), including:

- Type of activities taking place in the vicinity of the dwelling;
- Equipment being used near the dwelling, especially equipment such as water pumps, compressors and air conditioners;
- Whether there are any windmills (*"windpompe"*) close to the dwelling as well as their general maintenance condition;
- Type of trees around dwelling (conifers vs. broad-leaved trees, habitat that it provides to birds, food that it may provide to birds);

- The number, type and distance between the dwelling (measuring point) and trees. This is especially relevant when the trees are directly against the house (where the branches can touch the roof);
- Distance to large infrastructural developments, including roads, railroads and even large diameter pipelines;
- Distances to other noise sources, whether anthropogenic or natural (such as the ocean or running water);
- The material used in the construction of the dwelling;
- The design of the building, including layout and number of openings;
- How well the dwelling is maintained; and
- The type and how many farm animals are in the vicinity of the dwelling.

4.4 AMBIENT SOUND MEASUREMENTS

Ambient sound levels were measured at two locations over 35 hours from the afternoon of the 14th until the morning of the 16 October 2012. The sound level meters were referenced at 1,000 Hz directly before and after the measurements were taken. In all cases drift was less than 0.2 dBA.

The data indicate an area where ambient sound levels are elevated, mainly due to natural sound sources relating to bird communication as well as wind induced noises. Ambient sound levels are also illustrated on **Figure 6-1**. As illustrated on this figure, ambient sound levels does increase as wind speeds increase and sound levels ranging between 45 and 60 dBA are expected during periods when the WEF may be operational.

5 POTENTIAL NOISE SOURCES

5.1 CHANGES IN NOISE SOURCES: OPERATIONAL PHASE

The developer proposes to change the layout and amend to the turbine specifications for the Zen WEF. The intended amendments include:

- Reduction in the number of turbines from **46** to **27**;
- Increase rated power of turbines from **3 MW** to up to **6 MW** per WTG;
- Increase rotor diameter from **122 m** to up to **165 m**;
- Increase hub height from **110 m** to up to **140 m**.

For the purpose of this noise assessment the sound power emission levels of the GE 3.6-137 wind turbine was used. The 2013 noise study made use of the sound power emission levels of the ECO 110 wind turbine. The sound power emission level curves are illustrated for these wind turbines in **Figure 5-1** together with the curve for the Vestas V90 wind turbine (used for the cumulative impact assessment for the Gouda WEF).

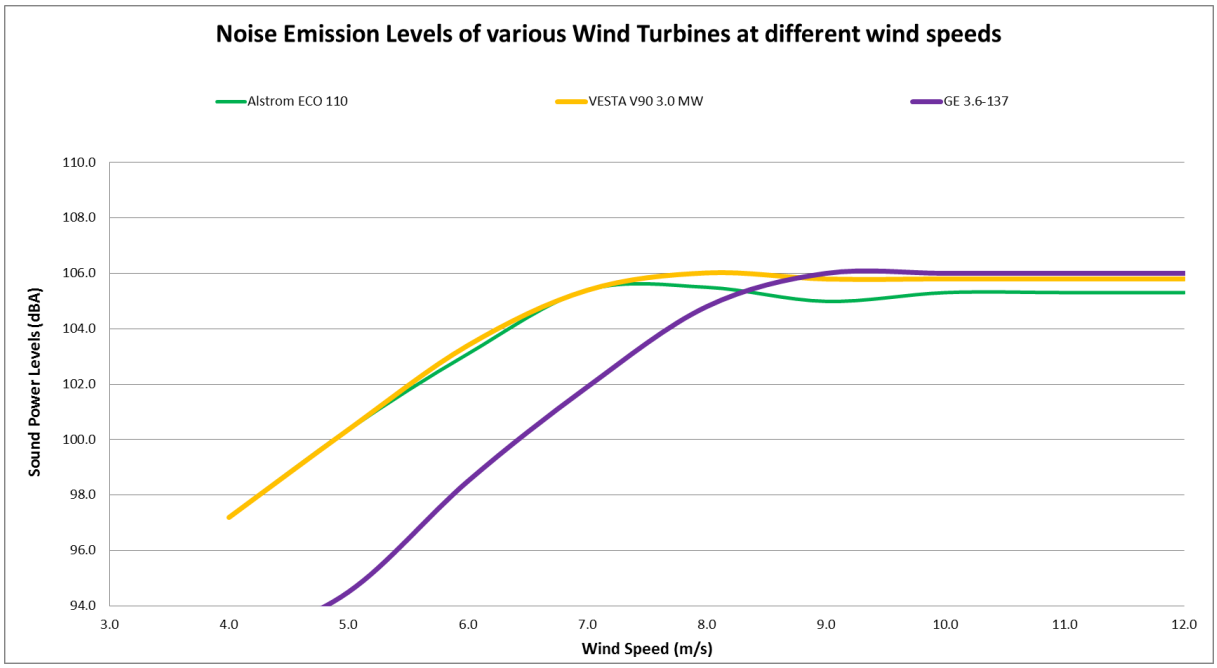

Figure 5-1: Noise Emissions Curve of a number of different wind turbines

The propagation model makes use of various frequencies, because these frequencies are affected in different ways as it propagates through air, over barriers and over different ground conditions providing a higher accuracy than models that only use the total sound power level. The octave sound power levels for various wind turbines are presented on **Figure 5-2**.

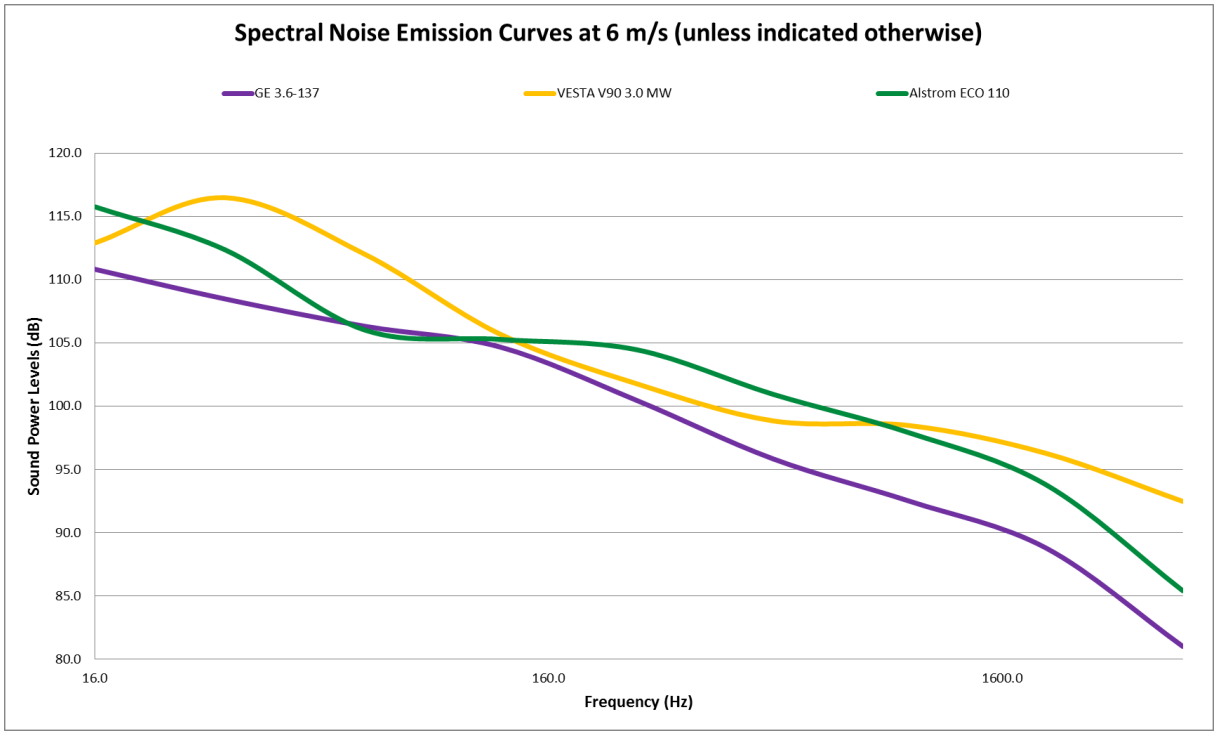

Figure 5-2: Octave sound power emissions of various wind turbines

6 METHODS: NOISE IMPACT ASSESSMENT AND SIGNIFICANCE

6.1 DETERMINING APPROPRIATE ZONE SOUND LEVELS

SANS 10103:2008 does not cater for instances when background ambient sound levels change due to the impact of external forces. Locations close (closer than 500 meters from coastline) from the sea for instance always has an ambient sound level exceeding 35 dBA, and, in cases where the sea is rather turbulent, it can easily exceed 45 dBA. Similarly, noise induced by high winds is not considered in the SANS standard.

Setting noise limits relative to the ambient sound level is relatively straightforward when the prevailing ambient sound level and source level are constant. However, wind turbines only start to operate when wind speeds exceed 3 m/s. Noise emissions therefore relates to the wind speed and similarly, the environment in which they are heard also depends upon the strength of the wind and the noise associated with its effects. It is therefore necessary to derive an ambient sound level that is indicative of the noise environment at the receiving property for different wind speeds so that the turbine noise level at any particular wind speed can be compared with the ambient sound level in the same wind conditions.

6.1.1.1 Using International Guidelines to set Noise Limits

When assessing the overall noise levels emitted by a Wind Energy Facility, it is necessary to consider the full range of operating wind speeds of the wind turbines. This covers the wind speed range from around 3-5 m/s (the turbine cut-in wind speed) up to a wind speed range of 25-35 m/s measured at the hub height of a wind turbine. However, ETSU-R97 (1996) proposes that noise limits only be placed up to a wind speed of 12 m/s for the following reasons:

1. Wind speeds are not often measured at wind speeds greater than 12 m/s at 10 m height;
2. Reliable measurements of background ambient sound levels and turbine noise will be difficult to make in high winds due to the effects of wind noise on the microphone and the fact that one could have to wait several months before such winds were experienced;
3. Turbine manufacturers are unlikely to be able to provide information on sound power levels at such high wind speeds for similar reasons; and
4. If a wind farm meets noise limits at wind speeds lower than 12m/s, it is most unlikely to cause any greater loss of amenity at higher wind speeds. Turbine noise levels increase only slightly as wind speeds increase; however, background ambient sound levels increase significantly with increasing wind speeds due to the force of the wind.

Ambient sound vs. wind speed data is presented in **Figure 6-1**[1]. This is a quiet (as per the opinion of the author) location[2] where there were no apparent or observable sounds that would have impacted on the measurements, presenting the A-Weighted sound levels at an inland area. The figures clearly indicate a trend where sound levels increase if the wind speed increases. This has been found at all locations where measurements have been done for a sufficiently long enough period of time (more than 30 locations – more than 38,000 measurements).

Sound measurement levels collected at the proposed Zen WEF site during 2012 also show that ambient sound levels increase as the wind speed increase, with wind induced-noises significant and dominant at both measurement locations. L_{A90} statistical levels however indicate a potential for low ambient sound levels at wind speeds less than 6 m/s. This however should be compared with the sound power emission levels defined in in **Table 7-2** for the Vestas wind turbine considered to be used on the site.

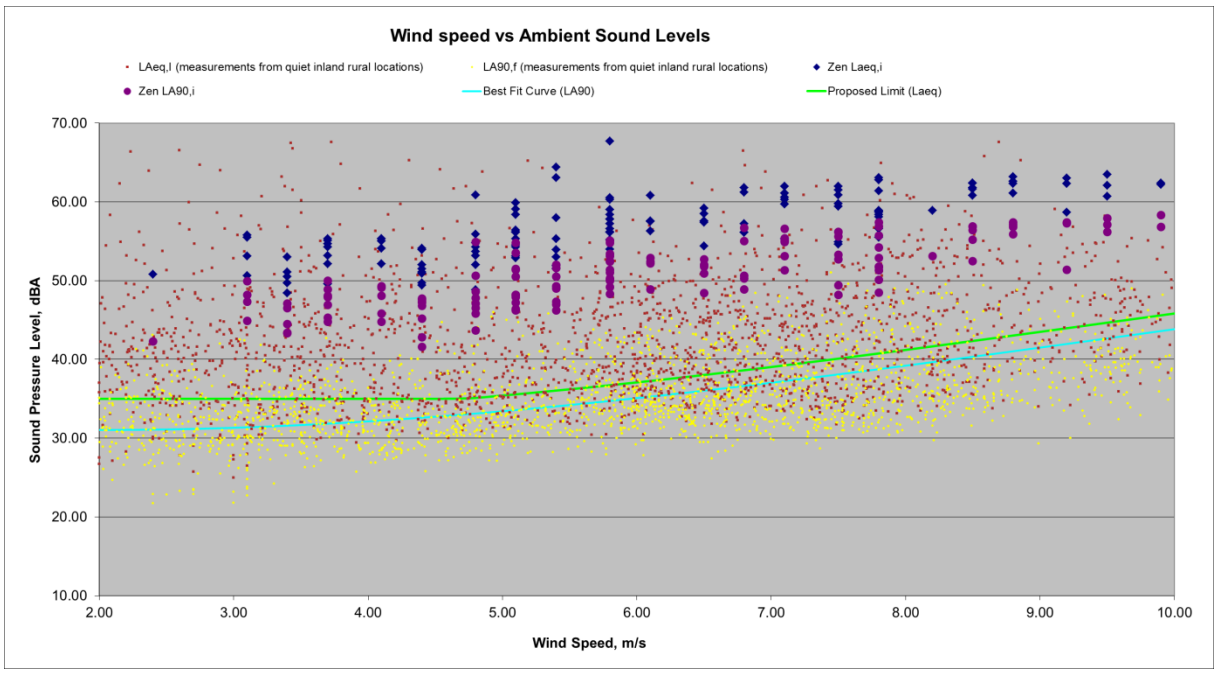

Figure 6-1: Ambient sound levels – quiet inland location (A-Weighted)

Considering this data as well as the international guidelines, noise limits starting at 40 dB that increases to more than 45 dB (as wind speeds increase) is acceptable.

[1] The sound level measuring instruments were located at a quiet location in the garden of the various houses. Data was measured in 10-minute bins and then co-ordinated with the 10 m wind speed derived from the wind mast of the developer. This wind mast normally was not close to the dwelling, at times being further than 5,000 meters from the measurement location. It is possible that the wind may be blowing at the location of the wind mast with no wind at the measurement location, resulting in low sound levels recorded.

[2] Different area where longer measurements were collected.

In addition, project participants could be exposed to noise levels up to 45 dBA (ETSU-R97) at lower wind speeds.

6.1.1.2 Using local regulations to set noise limits

Noise limits as set by the Provincial Noise Control Regulations (PN 200 of 2013 defines a "**disturbing noise**" as the noise that —

(a) exceeds the rating level by 7 dBA;

(b) exceeds the residual noise level where the residual noise level is higher than the rating level;

(c) exceeds the residual noise level by 3 dBA where the residual noise level is lower than the rating level; or

(d) in the case of a low-frequency noise, exceeds the level specified in Annex B of SANS 10103;

Based developmental character, much of the area is a rural noise district, night-time rating levels would be 35 dBA and a noise level exceeding 42 dBA could be a disturbing noise (therefore the noise limit). The daytime rating level is 45 dBA (52 dBA for a disturbing noise). Considering **Figure 6-1** this will be unlikely as the ambient sound levels (the residual noise levels) are very high at the two measurement locations and the rating level should be higher (based on the findings of onsite sound measurements).

6.2 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 Environmental Noise Impact Assessment stage.

The impact consequence is determined by the summing the scores of Magnitude (**Table 6-1**), Duration (**Table 6-2**) and Spatial Extent (**Table 6-3**). The impact significance is determined by multiplying the Consequence result with the Probability score (**Table 6-4**).

An explanation of the impact assessment criteria is defined in the following tables.

Table 6-1: 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**
Low	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 Medium	Increase in average sound pressure levels between 3 and 5 dB from the (expected) wind induced ambient sound level (proposed rating level). The change is barely discernible, but the noise source might become audible.	4
Medium	Increase in average sound pressure levels between 5 and 7 dB from the (expected) wind induced ambient sound level (proposed rating level). Sporadic complaints expected. Any point where the zone sound levels are exceeded during wind still conditions.	6
Severe / High	Increase in average sound pressure levels between 7 and 10 dB from the (expected) wind induced ambient sound level (proposed rating level). Medium to widespread complaints expected.	8
Very Severe / Very High	Increase in average sound pressure levels higher than 10 dBA 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 6-2: 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.	1
Short term	Impacts that are predicted to last only for the duration of the construction period (less than 5 years).	2
Medium term	Impacts that will continue for 5 to 20 years.	3
Long term	Impacts that will continue for the life of the Project, but ceases when the Project stops operating (20 to 40 years).	4
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 (over 40 years).	5

Table 6-3: Impact Assessment Criteria – Spatial extent

Classification of the physical and spatial scale of the impact		
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 site).	2

Regional	The impact could affect the area including the neighbouring farms, the transport routes and the adjoining towns.	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 6-4: 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**
Improbable	The possibility of the impact occurring is none, due either to the circumstances, design or experience. The chance of this impact occurring is zero (0 %).	1
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
Likely	There is a possibility that the impact will occur to the extent that provisions must therefore be made. The chances of this impact occurring is defined to be between 25% and 50 %.	3
Highly Likely	It is most likely that the impacts will occur at some stage of the development. Plans must be drawn up before carrying out 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

6.3 REPRESENTATION OF NOISE LEVELS

Noise rating levels will be calculated in the ENIA report using the appropriate sound propagation models as defined. 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, **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 was added. These noise rating levels are further processed into a 3D map illustrating noise contours of constant rating levels or noise isopleths. In the ENIA it will be used to illustrate the potential extent of the calculated noises of the complete project and not noise levels at a specific moment in time.

7 PROJECTED NOISE RATING LEVELS

7.1 PROPOSED CONSTRUCTION PHASE NOISE IMPACT

Construction activities are highly dependent on the final operational layout. The layout as assessed in the EIA process is presented in **Figure 7-1**. As can be seen from this layout, a number of different activities might take place close to potentially sensitive receptors, each with a specific potential impact.

The change in the layout is significant, with a number of wind turbines relocated closer to previously identified NSD in the area. The projected construction noise levels are depicted at **Figure 7-2**.

The change in the layout may result in the noise level increasing with approximately 3 dBA at NSDs 01 and 02 as well as an increase of approximately 6 dBA at NSD18. The previous and future projected construction noise levels are defined in **Table 7-1**.

Table 7-1: Noise rating levels at closest potential noise-sensitive receptors due to construction noises

NSD	Previous Construction Noise rating levels (dBA)	Proposed Construction Noise rating levels (dBA)	NSD	Previous Construction Noise rating levels (dBA)	Proposed Construction Noise rating levels (dBA)	Daytime rating levels (dBA)	Night-time rating levels (dBA)
NSD01	41.0	44.1	NSD14	34.9	36.9	45	35
NSD02	41.8	44.4	NSD15	29.6	36.7	45	35
NSD03	42.0	43.7	NSD16	31.8	36.1	45	35
NSD04	37.7	38.3	NSD17	29.3	38.6	45	35
NSD05	38.0	38.2	NSD18	36.4	41.8	45	35
NSD06	36.3	37.5	NSD19	36.2	40.2	45	35
NSD07	32.0	36.8	NSD20	34.7	41.2	45	35
NSD08	29.9	36.1	NSD21	34.9	38.9	45	35
NSD09	29.8	36.4	NSD22	35.2	37.7	45	35
NSD10	28.1	35.5	NSD23	33.7	37.1	45	35
NSD11	28.5	35.6	NSD24	37.5	37.4	45	35
NSD12	28.7	35.6	NSD25	37.6	38.3	45	35
NSD13	27.5	35.5	NSD26	34.9	38.3	45	35

Figure 7-1: Wind Turbine Locations for the Zen WEF

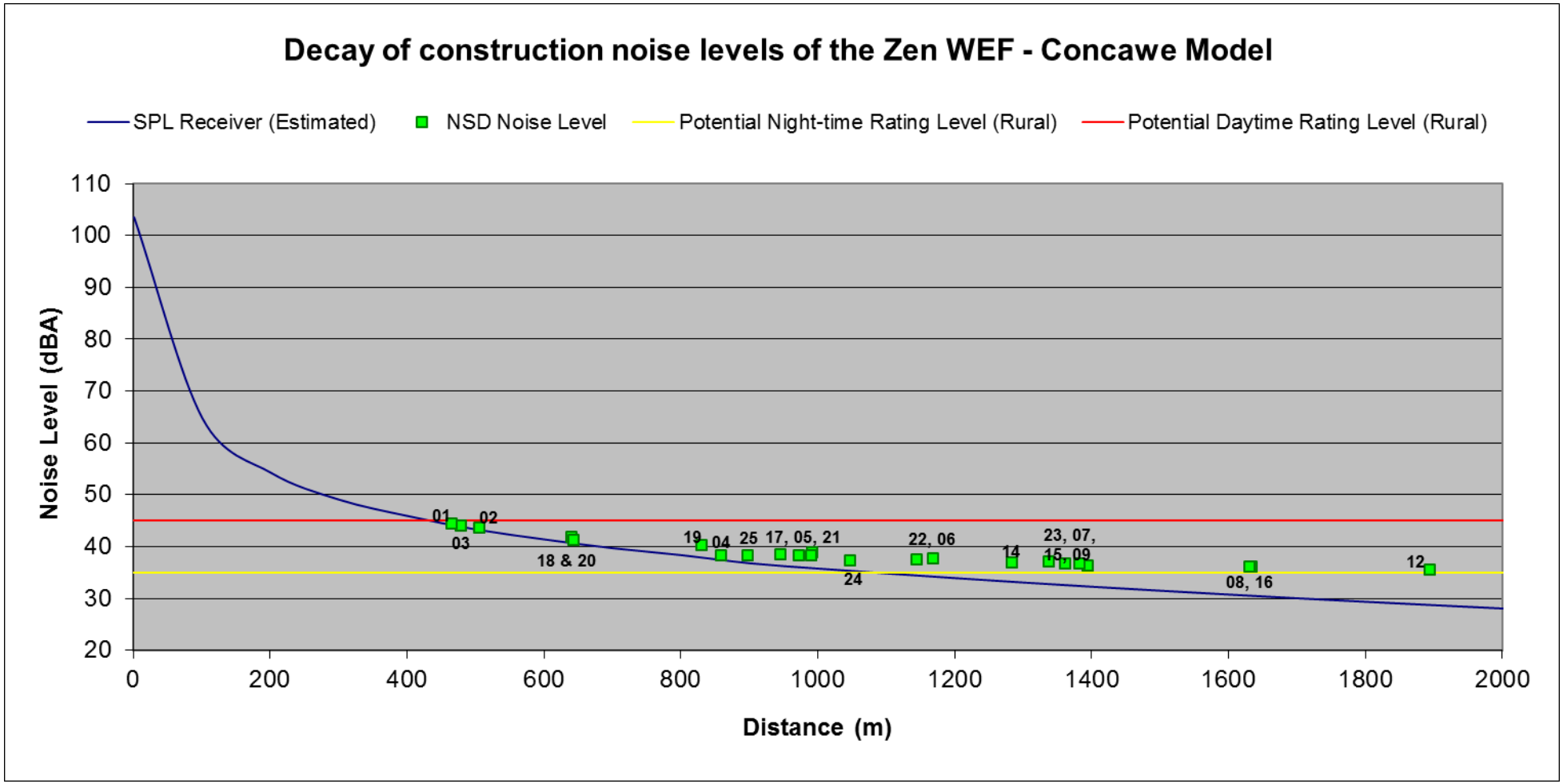

Figure 7-2: Projected construction noise levels[3] – Decay of noise from conceptual construction activities

[3] The SPL Receiver graph can also be used for the construction of the overhead power line to allow connection to the ESKOM grid. Any activities further than 500 m from any receiver will have a noise impact of low significance (daytime construction activities).

7.2 OPERATIONAL PHASE NOISE IMPACT

The daytime period was not considered during the EIA process as noises generated during the day by the WEF is generally masked by other noises from a variety of sources surrounding potentially noise-sensitive developments. However, times when a quiet environment is desired (at night for sleeping, weekends etc.) ambient sound levels are more critical. The time period investigated therefore would be a quieter period, normally associated with the 22:00 – 06:00 timeslot. Maintenance activities would therefore not be considered, concentrating on the ambient sound levels created due to the operation of the various Wind Turbine Generators (WTG's) at night.

The presented layout (see **Figure 7-1**) was modelled in detail using the sound power emission levels for the GE 3.6-137 wind turbine as defined in **Table 7-2**.

Table 7-2: Octave Sound Power Emission Levels used for modelling: GE 3.6-137 WTG

Wind Turbine: GE 3.6-137										
Source Reference: Noise_Emissions-NO_3.6-DFIG-137-xxHz_3MW_IEC_Eng-a1_EN_r02										
Octave Sound Power Levels										
	16.0	**31.0**	**63.0**	**125.0**	**250.0**	**500.0**	**1000.0**	**2000.0**	**4000.0**	
Adjustment	*-56.4*	*-39.9*	*-26.2*	*-16.2*	*-8.7*	*-3.2*	*0.0*	*1.2*	*1.0*	
A-Weighted Sound Power Levels										
4.0	49.2	63.8	75.5	83.3	86	86.5	86.7	83.2	73.6	92.5
5.0	50.6	65	76.5	84.7	87.8	88.4	88.5	86.3	77.6	94.5
6.0	54.4	68.6	80.1	88.5	91.8	92.6	92.5	90	82	98.5
7.0	57.6	71.6	83.1	91.5	95.3	96.2	95.9	93.2	85.3	101.9
8.0	60.3	74.3	85.7	94.1	98	99.2	99	96	87.9	104.8
9.0	61.9	75.8	87.4	95.3	98.8	100.4	100.4	97.4	89	106
10.0	62	75.9	87.4	95.4	98.8	100.3	100.4	97.5	89	106
12.0+	62	76	87.5	95.3	98.5	100.4	100.8	97.2	87	106

Total noise rating levels is illustrated in **Figure 7-5** with **Table 7-3** defining the noise rating levels at the closest potential noise-sensitive receptors (maximum noise emission levels – 106 dBA at a 10 m/s wind speed). This WTG has a sound power emission level similar to the sound power emission levels of the Alstom ECO-110 and 122 considered in the 2013 assessment (report SE-ZWEF/ENIA/201311-Rev 1).

Figure 7-3 illustrate the noise rating levels for different wind speeds as evaluated in 2018 (report ZT-ZWEF/ENIA/201808-Rev 0), with **Figure 7-4** illustrating the noise rating levels for different wind speeds for the current layout.

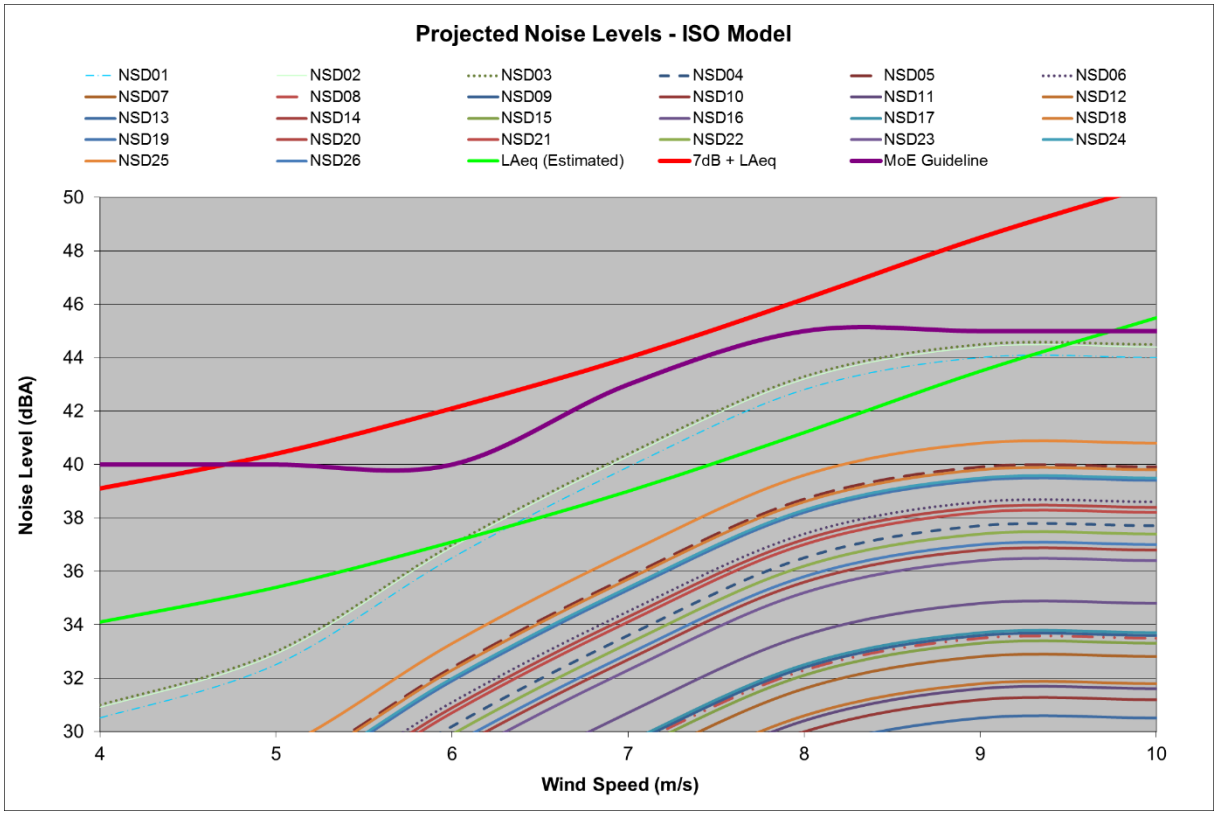

Figure 7-3: Projected noise levels at NSDs – Previous layout

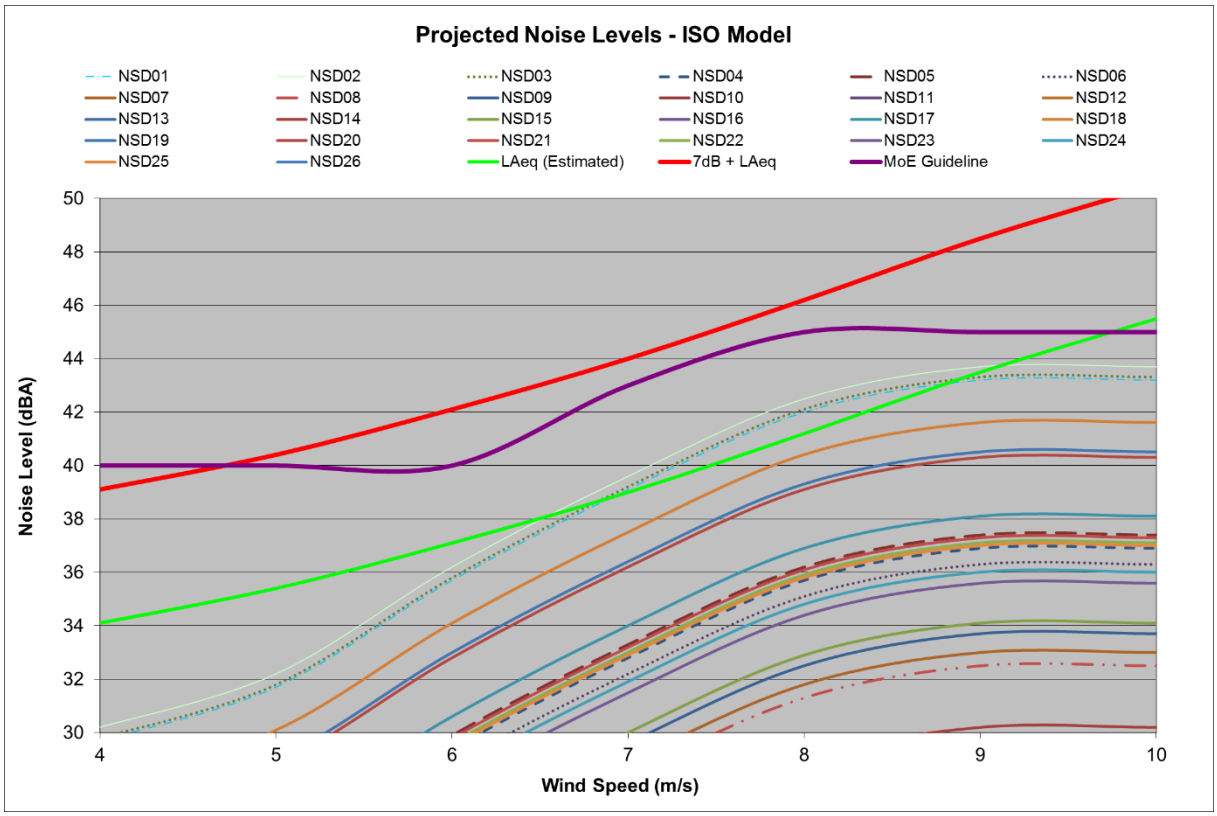

Figure 7-4: Projected noise levels at NSDs – Current layout

7.3 POTENTIAL CUMULATIVE NOISE IMPACTS

Cumulative noise impacts generally only occur when noise sources (such as other wind turbines) are closer than 2,000m from each other (around 1,000m from the conceptual receptor located between them). The cumulative impact also only affects the area between the wind turbines of the various wind farms.

If the wind turbines of one wind farm are further than 2,000m from the wind turbines of the other wind farm, the magnitude (and subsequently the significance) of the cumulative noise impact is reduced. If the distance between the wind turbines of two wind farms are further than 4,000m, cumulative noise impacts are non-existent (see also **Figure 7-7**).

The only wind farm sufficiently close to result in a potential cumulative noise impact is the operational Gouda WEF, located just south of the proposed Zen WEF. There are no other WEFs closer to this WEF and their wind turbines are further than 5km from the wind turbines of the proposed Zen WEF and pose no cumulative noise risk to the soundscape in the vicinity of the Zen WEF.

The developer of the neighbouring Gouda Wind Farm had indicated that the Enercon E82 wind turbine would be used. Unfortunately the 3rd octave sound power levels for this turbine was not available with the compilation of the report, but based on the total sound power level of the Enercon, the Vestas V90 3.0 MW turbine (operating in mode 2), for which 3rd octave sound power levels are available will be used. While the 3rd octave spectrum characteristics may differ, the total sound power levels are sufficiently close to provide an indication of the potential noise impacts.

Table 7-3: Noise rating levels at closest potential noise-sensitive receptors at a 10m/s wind speed

NSD	Noise rating levels, Zen WEF (dBA)	Cumulative Noise Rating Levels (dBA)	NSD	Noise rating levels, Zen WEF (dBA)	Cumulative Noise Rating Levels (dBA)	Likely sound levels based on Figure 6-1.
NSD01	43.2	43.3	NSD14	30.2	30.3	45 – 50 dBA
NSD02	43.7	43.8	NSD15	34.1	34.1	45 – 50 dBA
NSD03	43.3	43.4	NSD16	27.5	27.6	45 – 50 dBA
NSD04	36.9	36.9	NSD17	38.1	38.1	45 – 50 dBA
NSD05	37.4	37.4	NSD18	41.6	41.6	45 – 50 dBA
NSD06	36.3	36.3	NSD19	40.5	40.5	45 – 50 dBA
NSD07	33	33	NSD20	40.3	40.3	45 – 50 dBA
NSD08	32.5	32.5	NSD21	37.3	37.4	45 – 50 dBA

NSD09	33.7	33.7	NSD22	37.1	37.1	45 – 50 dBA
NSD10	27.6	27.6	NSD23	35.6	35.6	45 – 50 dBA
NSD11	29	29	NSD24	36	36	45 – 50 dBA
NSD12	28.4	28.4	NSD25	37	42.1	45 – 50 dBA
NSD13	24.7	24.7	NSD26	35.2	35.2	45 – 50 dBA

7.4 DECOMMISSIONING AND CLOSURE PHASE NOISE IMPACT

The potential for a noise impact to occur during the decommissioning and closure phase will be much lower than that of the construction and operational phases and noise from the decommissioning and closure phases will therefore not be investigated further.

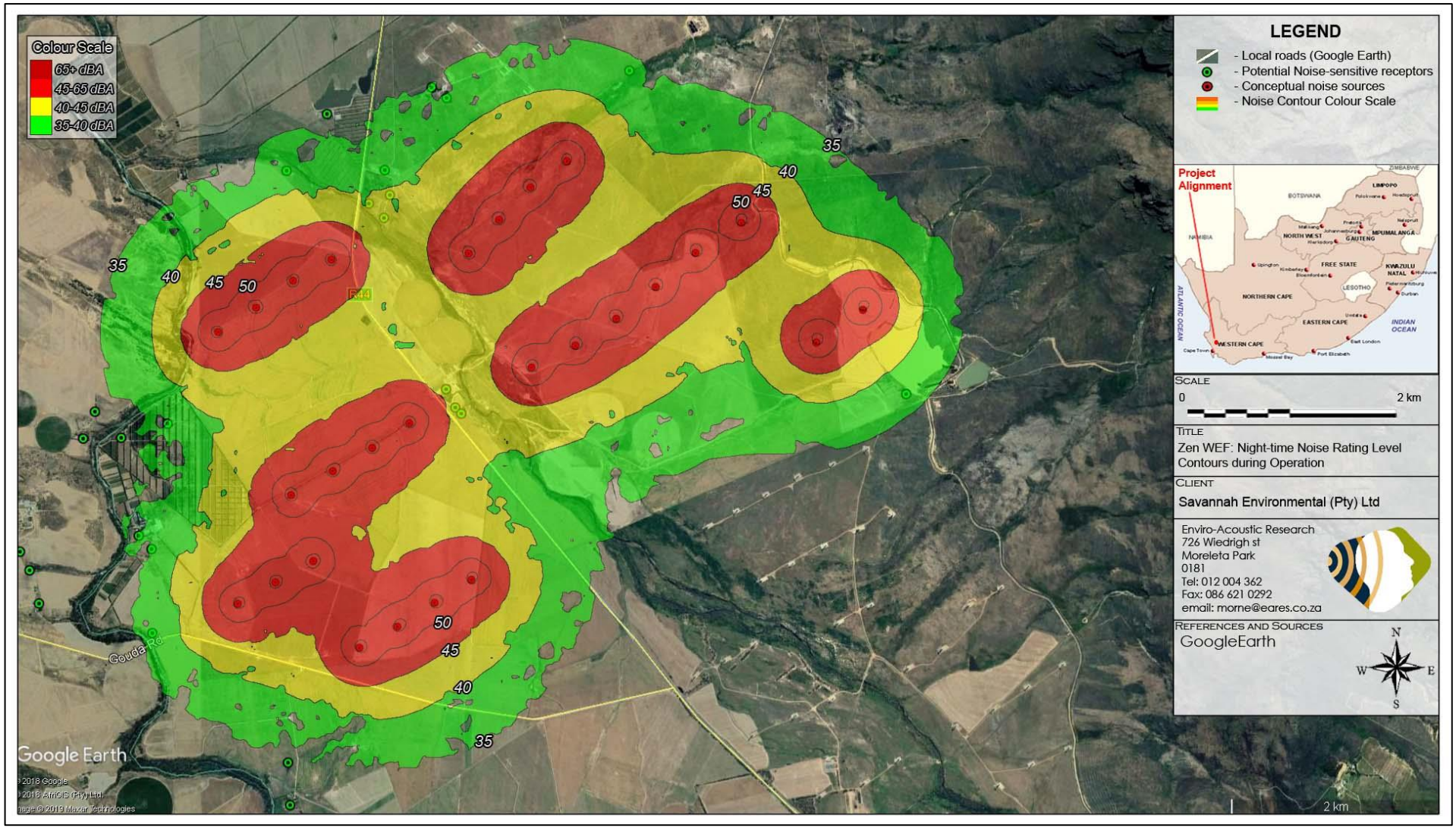

Figure 7-5: Projected conceptual noise rating levels of the Zen WEF during operation

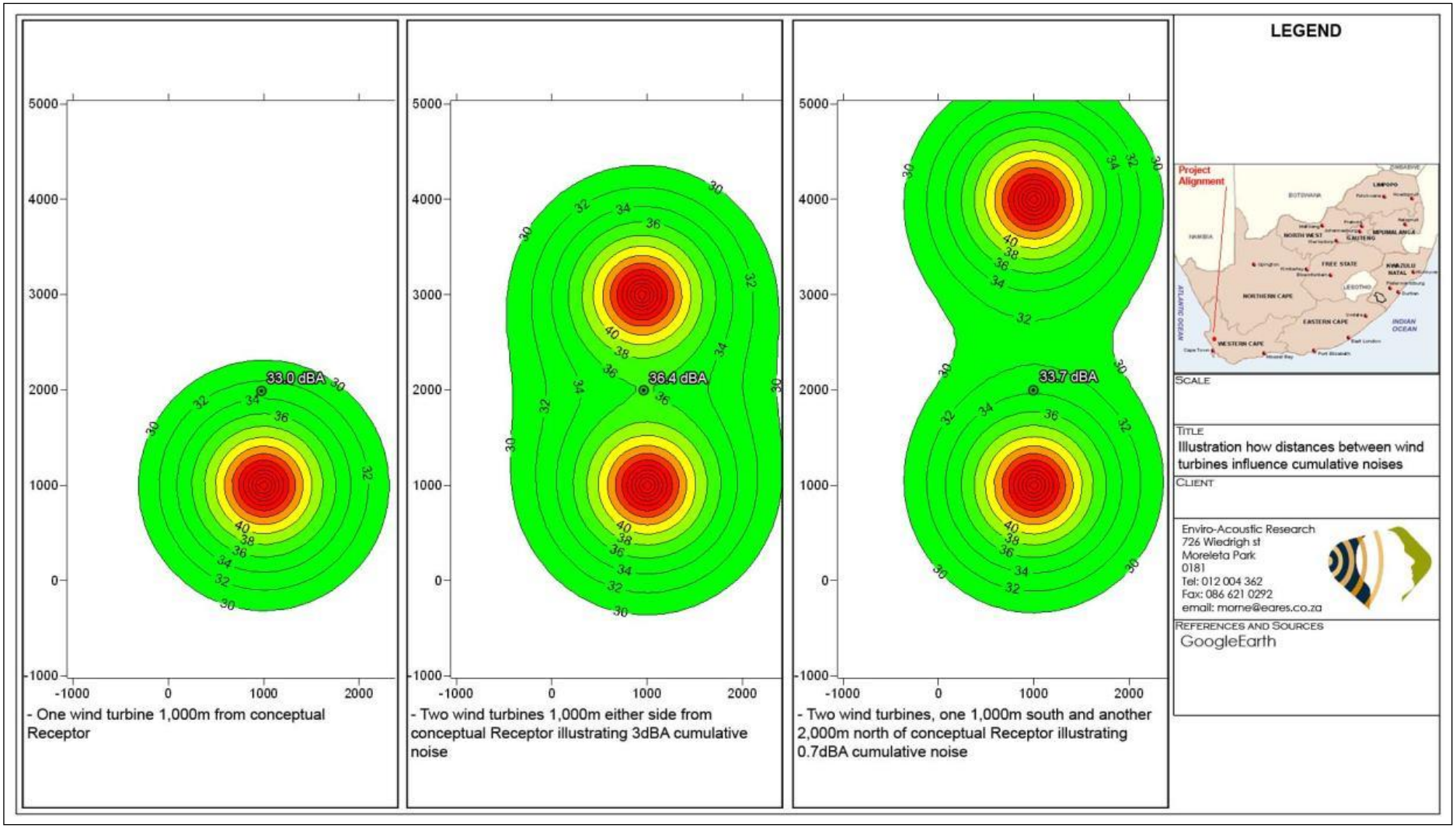

Figure 7-6: Effect of distance between wind turbines – potential cumulative noise

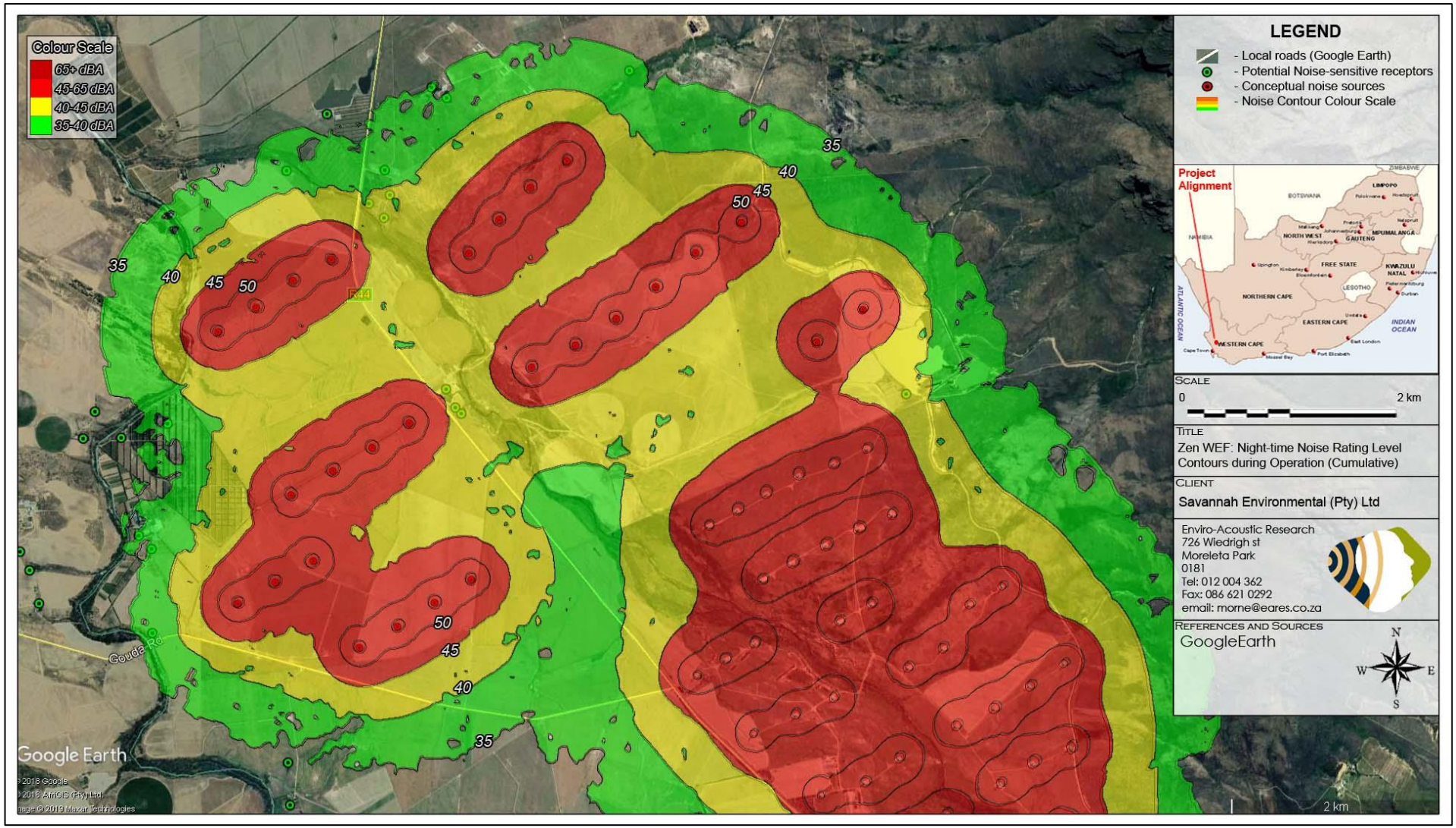

Figure 7-7: Projected cumulative noise rating levels – worst-case

8 COMPARATIVE NOISE IMPACT ASSESSMENT

8.1 CONSTRUCTION PHASE NOISE IMPACT

Considering the projected noise levels and how construction activities may impact on the surrounding receptors there is a low risk for a noise impact for daytime activities. Night-time construction activities were not assessed in the 2012 study (report ZT-ZWEF/ENIA/201211-Rev 0).

The proposed amendments to the layout will slightly increase the noise level at surrounding NSD, but the projected noise level is still less than 45 dBA. The significance of the proposed changes are defined in **Table 8-1**. The change in the turbine specifications will not have an impact on construction noises.

Table 8-1: Projected significance of daytime construction activities

Nature of Impact: Increased noise levels due to daytime construction activities.				
	Authorized		**Proposed Amendment**	
	Without mitigation	**With mitigation**	**Without mitigation**	**With mitigation**
Extent	Local (2)	Local (2)	Local (2)	Local (2)
Duration	Temporary (1)	Temporary (1)	Temporary (1)	Temporary (1)
Magnitude	High (8)	High (8)	High (8)	High (8)
Probability	Possible (2)	Possible (2)	Possible (2)	Possible (2)
Significance	Low (22)	Low (22)	Low (22)	Low (22)
Status	Negative	Negative	Negative	Negative
Reversibility	High	High	High	High
Irreplaceability	Not relevant	Not relevant	Not relevant	Not relevant
Mitigated available	Yes, not required	Yes, not required	Yes, not required	Yes, not required
Mitigation: No mitigation is required for daytime construction activities. No night-time construction activities are recommended closer than 500 m from residential dwellings.				
Cumulative Impacts: Construction noises will cumulative increase existing ambient sound levels. Cumulative effects however are less than 3 dB and of low significance.				
Residual Risks: The impacts will disappear after the construction and operational phases.				

8.2 OPERATIONAL PHASE NOISE IMPACT

Only the night-time scenario was assessed (as per previous reports), as this is the most critical time period when a quiet environment is desired. The noise rating levels are calculated in **section 7.2** for the various operational activities defined in section **5.1**. Report SE-ZWEF/ENIA/201311-Rev 1 determined a significance of low.

As can be seen from **Table 7-3**, the projected noise rating levels will be less than 45 dBA at all NSD, with the updated layout resulting a slight reduction in the noise rating levels at NSDs 1, 2 and 3. The noise rating levels will increase at NSDs 18, 19 and 20 but the total noise levels will be well less than 45 dBA.

Therefore, the proposed change in layout and wind turbine specifications will not alter the findings of the 2013 Noise Impact Assessment as defined in **Table 8-2**.

Table 8-2: Projected significance of night-time operational activities

Nature of Impact: Increased noise levels due to night-time operational activities.				
	Authorized		**Proposed Amendment**	
	Without mitigation	**With mitigation**	**Without mitigation**	**With mitigation**
Extent	Local (2)	Local (2)	Local (2)	Local (2)
Duration	Long (4)	Temporary (1)	Temporary (1)	Temporary (1)
Magnitude	High (8)	High (8)	High (8)	High (8)
Probability	Possible (2)	Possible (2)	Possible (2)	Possible (2)
Significance	Low (28)	Low (28)	Low (28)	Low (28)
Status	Negative	Negative	Negative	Negative
Reversibility	High	High	High	High
Irreplaceability	Not relevant	Not relevant	Not relevant	Not relevant
Mitigated available	Yes, not required	Yes, not required	Yes, not required	Yes, not required
Mitigation: No mitigation is required for daytime construction activities. No night-time construction activities are recommended closer than 500 m from residential dwellings.				
Cumulative Impacts: Operational noises from the Zen WEF will cumulatively add to the noises from the Gouda WEF. This is only relevant for NSD25, where the calculated maximum noise level are 40.7 dBA (Gouda WEF turbines only), where noises from the Zen WEF will cumulatively raise the total noise level to 42.1 dBA. Cumulative effects however are less than 3 dB and of low significance.				
Residual Risks: The impacts will disappear after the construction and operational phases.				

9 CONCLUSIONS AND RECOMMENDATIONS

This report is a Comparative Environmental Noise Impact Assessment of the predicted noise environment for the proposed Zen Wind Energy Facility south of the town of Saron, making use of sound propagation models to identify issues of concern.

This assessment considers the potential change in noise impact due to the proposed changes in the layout and wind turbine specifications of the Zen WEF.

Considering the modelled construction and operational noise levels, the proposed changes to the layout and wind turbine specifications will not lead to any other noise impacts, neither will it change the significance of the noise impact as defined in the original reports. The findings and recommendations highlighted in the original 2012 and 2013 amendment would remain.

It should be noted that this assessment used the sound power emission levels of a wind turbine generating 106 dBA. Considering the projected noise rating levels at NSD02, the findings of this report will be valid, subject that the developer use a wind turbine with a maximum sound power emission level less than 107 dBA.

Considering the possible **low** significance of the noise impacts there is no reason that the proposed amendment of the Zen WEF cannot be authorised.

10 REFERENCES

In this report reference was made to the following documentation:

1. Acoustics, 2008: *A review of the use of different noise prediction models for wind farms and the effects of meteorology*
2. Acoustics Bulletin, 2009: *Prediction and assessment of wind turbine noise*
3. Ambrose, SE and Rand, RW, 2011. The Bruce McPherson Infrasound and Low Frequency Noise Study: Adverse health effects produced by large industrial wind turbines confirmed. Rand Acoustics, December 14, 2011.
4. Audiology Today, 2010: *Wind-Turbine Noise – What Audiologists should know*
5. Autumn, Lyn Radle, 2007: *The effect of noise on Wildlife: A literature review*
6. Atkinson-Palombo, C and Hoen, B. 2014: *Relationship between Wind Turbines and Residential Property Values in Massachusetts – A Joint Report of University of Connecticut and Lawrence Berkley National Laboratory.* Boston, Massachusetts
7. Bakker, RH *et al*. 2011: *Effects of wind turbine sound on health and psychological distress*. Science of the Total Environment (in press, 2012)
8. Bolin et al, 2011: *Infrasound and low frequency noise from wind turbines: exposure and health effects.* Environ. Res. Lett. 6 (2011) 035103
9. Bowdler, Dick, 2008: *Amplitude modulation of wind turbine noise: a review of the evidence*
10. Bray, W and James, R. 2011. Dynamic measurements of wind turbine acoustic signals, employing sound quality engineering methods considering the time and frequency sensitivities of human perception. Noise-Con 2011.
11. BWEA, 2005*: Low Frequency Noise and Wind Turbines – Technical Annex*
12. Chapman *et al*. 2013: Spatio-temporal differences in the history of health and noise complaints about Australian wind farms: evidence for the psychogenic, "communicated disease" hypothesis. Sydney School of Public Health, University of Sydney
13. Chief Medical Officer of Health, 2010: The Potential Health Impact of Wind Turbines, Canada
14. Cooper, 2012: Are Wind Farms too close to communities, The Acoustic Group (date posted on Wind-watch.org: Referenced on various anti-wind energy websites)
15. Crichton *et al*. 2014: *Can expectations produce symptoms from infrasound associated with wind turbines?. Health Psychology, Vol 33(4), Apr 2014, 360-364*
16. Cummings, J. 2012: Wind Farm Noise and Health: Lay summary of new research released in 2011. Acoustic Ecology Institute, April 2012 (online resource: http://www.acousticecology.org/wind/winddocs/AEI_WindFarmsHealthResearch2011.pdf)

17. Cummings, J. 2009: *AEI Special Report: Wind Energy Noise Impacts*. Acoustic Ecology Institute, (online resource: http://acousticecology.org/srwind.html)
18. DEFRA, 2003: *A Review of Published Research on Low Frequency Noise and its Effects*, Report for Defra by Dr Geoff Leventhall Assisted by Dr Peter Pelmear and Dr Stephen Benton
19. DEFRA, 2007: *Research into Aerodynamic Modulation of Wind Turbine Noise: Final Report*
20. DELTA, 2008: *EFP-06 project: Low Frequency Noise from Large Wind Turbines, a procedure for evaluation of the audibility for low frequency sound and a literature study*. Danish Energy Authority
21. Delta, 2014: *Measurement of Noise Emission from a Vestas V117-3.3 MW-Mk2-IEC2A-50Hz in Mode 0 wind turbine; serial no 201303, Performed for Vestas Wind Systems A/S*. Delta, Denmark. Report ID. DANAK 100/1854 Rev 2.
22. Duncan, E. and Kaliski, K. 2008: *Propagation Modelling Parameters for Wind Power Projects*
23. Enertrag, 2008: *Noise and Vibration*. Hempnall Wind Farm (http://www.enertraguk.com/technical/noise-and-vibration.html)
24. ETSU R97: 1996. '*The Assessment and Rating of Noise from Wind Farms: Working Group on Noise from Wind Turbines*'
25. Garrad Hassan, 2013: *Summary of results of the noise emission measurement, in accordance with IEC 61400-11, of a WTGS of the type N117/3000. Doc.* GLGH-4286 12 10220 258-S-0002-A (extract from GLGH-4286 12 10220 258-A-0002-A)
26. GE Renewable Energy, 2017: "*Techincal Documantation – Wind Turbine Generator Systems 3.6-137 – 50/60 Hz: Product Acoustic Specifications*".
27. Gibbons, S. 2014: *Gone with the Wind: Valuing the Visual Impacts of Wind turbines through House Prices*, Spatial Economics Research Centre
28. Hanning, 2010: *Wind Turbine Noise, Sleep and Health*. (referenced on a few websites, especially anti-wind energy. No evidence that the study has been published formally.)
29. Havas, M and Colling, D. 2011: *Wind Turbines Make Waves: Why Some Residents Near Wind Turbines Become Ill*. *Bulletin of Science Technology & Society published online 30 September 2011*
30. Hessler, D. 2011: Best Practices Guidelines for Assessing Sound Emissions From Proposed Wind Farms and Measuring the Performance of Completed Projects. Prepared for the Minnesota Public Utilities Commission, under the auspices of the National Association of Regulatory Utility Commissioners (NARUC)
31. HGC Engineering, 2006: *Wind Turbines and Infrasound*, report to the Canadian Wind Energy Association

32. HGC Engineering, 2007: *Wind Turbines and Sound*, report to the Canadian Wind Energy Association
33. HGC Engineering, 2011: *Low frequency noise and infrasound associated with wind turbine generator systems: A literature review*. Ontario Ministry of the Environment RFP No. OSS-078696.
34. ISO 9613-2: 1996. '*Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation*'
35. Jeffery *et al*, 2013: Adverse health effects of industrial wind turbines, Can Fam Physician, 2013 May. 59(5): 473-475
36. Jongens, AWD. 2011: *'Environmental Noise Impact study into the proposed establishment of a wind farm at Riebeek East in the Eastern Cape'.* Jongens, Keet Associates Acoustical Engineering Consultants, Constantia.
37. Journal of Acoustical Society of America, 2009: *Response to noise from modern wind farms in the Netherlands*
38. Kamperman, GW. and James, RR, 2008: *The "How to" guide to siting wind turbines to prevent health risks from sound*
39. Knopper, LD and Ollsen, CA. 2011. Health effects and wind turbines: A review of the literature. Environmental Health 2011, 10:78
40. Kroesen and Schreckenberg, 2011. A measurement model for general noise reaction in response to aircraft noise. J. Acoust. Soc. Am. 129 (1), January 2011, 200-210.
41. McMurtry, RY. 2011: *Toward a Case Definition of Adverse Health Effects in the Environs of Industrial Wind Turbines: Facilitating a Clinical Diagnosis*. Bulletin of Science Technology Society. August 2011 vol. 31 no. 4 316-320
42. Minnesota Department of Health, 2009: *Public Health Impacts of Wind Farms*
43. Ministry of the Environment, 2008: *Noise Guidelines for Wind Farms, Interpretation for Applying MOE NPC Publications to Wind Power Generation Facilities*
44. Møller, H. 2010: Low-frequency noise from large wind turbines. J. Acoust. Soc. Am, 129(6), June 2011, 3727 - 3744
45. Nissenbaum, A. 2012: *Effects of industrial wind turbine noise on sleep and health*. Noise and Health, Vol. 14, Issue 60, p 237 – 243.
46. Noise-con, 2008: *Simple guidelines for siting wind turbines to prevent health risks*
47. Noise quest, Aviation Noise Information & Resources, 2010: http://www.noisequest.psu.edu/pmwiki.php?n=Main.HomePage
48. Norton, M.P. and Karczub, D.G.: Fundamentals of Noise and Vibration Analysis for Engineers, Second Edition, 2003
49. Oud, M. 2012:: Low-frequency noise: a biophysical phenomenon (http://www.leefmilieu.nl/sites/www3.leefmilieu.nl/files/imported/pdf_s/2012_OudM_Low-frequency%20noise_0.pdf) (unpublished webresource)

50. O'Neal, *et al*. 2011: *Low frequency noise and infrasound from wind turbines*. Noise Control Eng. J. 59 (2), March-April 2011.
51. Pedersen, Eja; Halmstad, Högskolan I, 2003: '*Noise annoyance from wind turbines: a review'*. Naturvårdsverket, Swedish Environmental Protection Agency, Stockholm
52. Pedersen, E. 2011: "*Health aspects associated with wind turbine noise—Results from three field studies",* Noise Control Eng. J. 59 (1), Jan-Feb 2011
53. Phillips, CV, 2011: *"Properly Interpreting the Epidemiologic Evidence About the Health Effects of Industrial Wind Turbines on Nearby Residents"*. Bulletin of Science Technology & Society 2011 31: 303 DOI: 10.1177/0270467611412554
54. Pierpont, N. 2009: *"Wind Turbine Syndrome: A Report on a Natural Experiment",* K Select Books, 2009
55. Punch, *et al*. 2010: *Wind Turbine Noise. What Audiologists should know.* Audiology Today. JulAug2010
56. Renewable Energy Research Laboratory, 2006: *Wind Turbine Acoustic Noise*
57. Report to Congressional Requesters, 2005: *Wind Power – Impacts on Wildlife and Government Responsibilities for Regulating Development and Protecting Wildlife*
58. SANS 10103:2008. 'The measurement and rating of environmental noise with respect to annoyance and to speech communication'.
59. SANS 10210:2004. 'Calculating and predicting road traffic noise'.
60. SANS 10328:2008. 'Methods for environmental noise impact assessments'.
61. SANS 10357:2004 The calculation of sound propagation by the Concave method'.
62. Sheperd, D and Billington, R. 2011: *Mitigating the Acoustic Impacts of Modern Technologies: Acoustic, Health, and Psychosocial Factors Informing Wind Farm Placement*. *Bulletin of Science Technology & Society* published online 22 August 2011, DOI: 10.1177/0270467611417841
63. Shepherd. D *et al*. 2011: *Evaluating the impact of wind turbine noise on health related quality of life*. Noise & Health, September-October 2011, 13:54,333-9.
64. Smith. M (*et al*) (2012): "*Mechanisms of amplitude modulation in wind turbine noise*"; Proceedings of the Acoustics 2012 Nantes Conference
65. Stigwood (*et al*) (2013): "*Audible amplitude modulation – results of field measurements and investigations compared to psycho-acoustical assessments and theoretical research*"; Paper presented at the 5th International Conference on Wind Turbine Noise, Denver 28 – 30 August 2013
66. Tachibana, H (*et al*) (2013): "*Assessment of wind turbine noise in immission areas*"; Paper presented at the 5th International Conference on Wind Turbine Noise, Denver 28 – 30 August 2013
67. Thorne et al, 2010: *Noise Impact Assessment Report Waubra Wind Farm Mr & Mrs N Dean Report No 1537 - Rev 1*

68. Thorne, 2010: The Problems with "Noise Numbers" for Wind Farm Noise Assessment. Bulletin of Science Technology and Society, 2011 31: 262
69. USEPA, 1971: *Effects of Noise on Wildlife and other animals*
70. Van den Berg, G.P., 2003. *'Effects of the wind profile at night on wind turbine sound'.* Journal of Sound and Vibration
71. Van den Berg, G.P., 2004. *'Do wind turbines produce significant low frequency sound levels?'*. 11th International Meeting on Low Frequency Noise and Vibration and its Control
72. Wang, Z. 2011: *Evaluation of Wind Farm Noise Policies in South Australia: A Case Study of Waterloo Wind Farm*. Masters Degree Research Thesis, Adelaide University 2011
73. Whitford, Jacques, 2008: *Model Wind Turbine By-laws and Best Practices for Nova Scotia Municipalities*
74. World Health Organization, 2009: *Night Noise Guidelines for Europe*
75. World Health Organization, 1999: *Protection of the Human Environment; Guidelines for Community Noise*

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.
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 *SPL* or *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 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 metres, but not more than 1,4 metres, 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 metres, but not more than 1,4 metres, above the ground for a period of 24 hours, exceeds 61 dBA;
dB(A)	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	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	An Environmental Impact Assessment (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, and 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 continuous A-weighted rating level ($L_{Req,T}$)	The Equivalent continuous A-weighted sound exposure level *($L_{Aeq,T}$)* to which various adjustments has been added. More commonly used as ($L_{Req,d}$) over a time interval 06:00 – 22:00 (T=16 hours) and ($L_{Req,n}$) over a time interval of 22:00 – 06:00 (T=8 hours). It is a calculated value.
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 Hertz (Hz) or kiloHertz (kHz). One hundred Hz is a rate of one hundred times per second. The frequency of a sound is the property perceived as pitch: 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.
Green field	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.
Integrated Development Plan	A participatory planning process aimed at developing a strategic development plan to guide and inform all planning, budgeting, management and decision-making in a Local Authority, in terms of the requirements of Chapter 5 of the Municipal Systems Act, 2000 (Act 32 of 2000).
Integrated Environmental Management	IEM provides an integrated approach for environmental assessment, management, and decision-making and to promote sustainable development and the equitable use of resources. Principles underlying IEM provide for a democratic, participatory, holistic, sustainable, equitable and accountable approach.
Interested and affected parties	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 RMS (root mean squared) 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	Magnitude of impact means 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. Sound that a listener does not wish to hear (unwanted sounds). b. 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	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 Noise-sensitive developments is also referred to as a Potential Sensitive Receptor
Octave Band	A filter with a bandwidth of one octave, or twelve 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	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. 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.

End of report