REPORT

Sand Draai Concentrated Solar Technology Park

Parabolic Trough, Groblershoop, Northern Cape

Client:	SolAfrica
DEA Reference number:	14/12/16/3/3/3/205
Reference:	I&B-T01.JNB.000565-R002-F01
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Open

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Executive Summary

Royal HaskoningDHV Southern Africa Environmental Acoustics Unit was appointed to conduct the environmental noise impact of the proposed solar park facility located in the natural/rural regions of the Northern Cape Province of South Africa. The associated technology that is specifically under investigation in this report is the Parabolic Trough Technology and all associated infrastructure and activities.

A site investigation was completed in 2014 on the award of the project. The measurements concluded that the area of development has a natural profile and is impacted by animal, insects and wind sounds. The neighbouring Bokpoort Photovoltaic site was under construction at the time of measurements, however the operations was not audible onsite of the Sand Draai Farm (project locality).

The modelling scenarios investigated the construction phase for the solar power plant and associated infrastructure, and operational noise to be emitted from the alternative sites. The project required the acoustic consultant to investigate two alternative locations of the Parabolic Trough Technology on the farm of Sand Draai.

Based on the modelled calculations, Alternative 2 is the most preferred location for the Parabolic Trough infrastructures and operations, based on the fact that the associated infrastructure that had to be constructed to tie the plant into the local network will be the shortest. In stating that Alternative 2 is the preferred location, Alternative 1 is also acceptable, although the long access road could pose some nuisance to the local farming community in the region (Please refer to Figure 21).

In review of the results calculated from the propagation model in the previous section it indicates that the cumulative effect of the operations are minimal on the surrounding environment and the majority of noise will be localised to the source. This is in line with the findings of Tsoutsos *et al.* “The noise from the generating plant of large scale schemes [solar parks] is unlikely to cause any disturbance to the public.”

Staff Overview

Lodewyk Jansen	Senior Environmental Scientist – Environmental Noise
	Lodewyk Jansen is a Senior Environmental Noise Specialist at Royal HaskoningDHV, specialising in the monitoring, modelling, calculations and analysis of acoustic aspects impacting on the environment. Lodewyk comes from a background of environemntal sciences and found his feet in the acoustic field in his 7 years of work experience. He professionally registered as a natural sceientist (SACNASP – 400691/15), has an honours degree in Environmental Management and Geography (BSc. Hons) and is currently a member of the Institude of Acoustics (IOA), Acoustic Socity of America (ASA), National Association for Clean Air (NACA) and The South African Society for Atmospheric Sciences (SASAS). Lodewyk gained knowledge in a wide spectrum of industries and opperations regarding environmental acoustics. His focus is on ensuring client recieves an international quality product, not only addressing the impact but also in investigating the best possible mitigation measures required to reach the guidelines and standards for a sustainalbe future.

Declaration of Interest

I, ______Lodewyk Jansen______ declare that –

General Declaration:

- I act as the independent specialist in this application;
- I will preform work relating to the application in a manner, even if it 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 experience in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing – any decision to be taken with respect to the application by the competent authority; and – the objectivity of any report, plan, or document to be prepared by myself for submission to the competent authority; all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of Section 24F of the National Environmental Management Act.

Royal HaskoningDHV (Pty) Ltd

Name of company (if applicable)

Lodewyk Jansen

Name of Specialist

18 November 2015

Date

Specialist Signature

(Please refer to Appendix A for the completed declaration form as per governmental format and complete CV of Environmental Noise Specialist)

Acronyms

ASA	Acoustic Society of America
BL	Baseline
CAD	Computer aided drawings
CONCAWE	Conservation of Clean Air and Water in Europe
CRTN	Calculation of road traffic noise
CSP	Concentrated Solar Power
DEA	Department of Environmental Affairs
ECA	Environmental conservation Act
GIS	Geographic information system
GR	Governmental Notice
HP	High pressure
IFC EHS	International finance corporation - environmental health and safety
IOA	Institute of Acoustics
ISO	International Standards Organisation
JHB	Johannesburg
MIT	Mitigated phase
NACA	National Association for Clean Air
NE	North east
NEMA	National Environmental Management Act
NEMAQA	National Environmental Management: Air Quality Act
NRC	Noise reduction coefficient
OCSP	Operational phase of CSP
OHSAS	Occupational Health and Safety Advisory Services
OSHA	Occupational Safety and Health Administration
PV	Photovoltaic

REC	Receiver point
SABS	South African Bureau of Standards
SACNASP	South African Council for Natural Scientific Professions
SANS	South African National Standards
SASAS	South African Society of Atmospheric Sciences
SLM	Sound level meter
SPL	Sound Power Level
SW	South west
UK	United kingdom
WHO	World health organisation

Glossary

NOISE:	Unwanted sound that is annoying or interferes with listening. Not all noise needs to be excessively loud to represent an annoyance or interference.
SOUND:	Sound is an oscillation in pressure, stress particle displacement, particle velocity in a medium – in room temperature. (In air speed of sound is 1125'/second or one mile in 5 seconds.) Sound produces an auditory sensation caused by the oscillation.
ACOUSTICS:	The science of Sound. Its production, transmission and effects.
ABSORPTION:	The properties of a material composition to convert sound energy into heat thereby reducing the amount of energy that can be reflected.
ATTENUATION:	The reduction of sound energy as a function of distance travelled. (See also Inverse Square Law).
BACKGROUND NOISE:	The sum total of all noise generated from all direct and reflected sound sources in a space that can represent an interface to good listening and speech intelligibility. (Hearing impaired persons are especially victimized by background noise).
BARRIER:	Anything physical or an environment that interferes with communication or listening. A poor acoustical environment can be a barrier to good listening and especially so for persons with a hearing impairment.
BEL:	A measurement of sound intensity named in honour of Alexander Graham Bell. First used to relate intensity to a level corresponding to hearing sensation.
FREE FIELD:	Sound waves from a source outdoors where there are no obstructions.
FREQUENCY:	The number of oscillations or cycles per unit of time. Acoustical frequency is usually expressed in units of Hertz (Hz) where one Hz is equal to one cycle per second.
FREQUENCY ANALYSIS:	An analysis of sound to determine the character of the sound by determining the amount of sounds at various frequencies that make up the overall sound spectrum. i.e.: Higher Frequency Sound or Pitch vs. Low Frequency.
IMPACT SOUND:	The sound produced by the collision of two solid objects. Typical sources are footsteps, dropped objects, etc., on an interior surface (wall, floor, or ceiling) of a building.
INVERSE SQUARE LAW:	Sound levels fall off with distance travelled. Sound level drops off 6 dB from source point for every doubling of distance
NOISE REDUCTION COEFFICIENT (NRC):	The NRC of an acoustical material is the arithmetic average to the nearest multiple of 0.05 of its absorption coefficients at 4 one third octave bands with centre frequencies of 250, 500, 1000, 2000 Hertz.
NUISANCE:	A legal definition of a noise that offends or upsets the receiver because it is occurring at the wrong time in the wrong place or is of a character that annoys due to excessive tonal components or impulses.
OCTAVE BANDS:	Sounds that contain energy over a wide range of frequencies are divided into sections called bands. A common standard division is in 10 octave bands identified by their centre frequencies 31.5, 63, 125, 250, 500, 1000, 2000, 4000 Hz.
RESONANCE:	The emphasis of sound at a particular frequency.
RESONANT FREQUENCY:	A frequency at which resonance exists.
SEPTUM:	A thin layer of material between 2 layers of absorptive material. i.e.: foil, lead, steel, etc. that prevents sound wave from piercing through absorptive material.
SOUND ABSORPTION:	The property possessed by materials, objects and air to convert sound energy into heat. Sound waves reflected by a surface, causes a loss of energy. That energy not reflected is called its absorption coefficient.
SOUND ABSORPTION COEFFICIENT:	The fraction of energy striking a material or object that is not reflected. For instance if a material reflects 70% of the sound energy incident upon its surface, then its Sound Absorption Coefficient would be 0.30.
SOUND BARRIER:	A material that when placed around a source of noise inhibits the transmission of that noise beyond the barrier. Also, anything physical or an environment that interferes with communication or listening. For example, a poor acoustical environment can be a barrier to good listening and especially so for persons with a hearing impairment.
SOUND LEVEL METER:	A device that converts sound pressure variations in air into corresponding electronic signals. The signals are filtered to exclude signals outside frequencies desired.
SPL: SOUND PRESSURE LEVEL:	Quantity used to describe the loudness of a sound. The sound pressure level is expressed in decibels and is measured with a sound level meter. For example, a conversation between two people inside an average-size room will produce an average "A" weighted sound pressure level of 50 to 55 lb.
TIME WEIGHTED AVERAGE (TWA):	The yardstick used by the Occupational Safety and Health Administration (OSHA) to measure noise levels in the workplace. It is equal to a constant sound level lasting eight hours that would cause the same hearing damage as the variable noises that a worker is actually exposed to. (This hearing loss, of course, occurs over long-term exposures.)
WAVELENGTH:	Sound that passes through air it produces a wavelike motion of compression and Parefaction. Wavelength is the distance between two identical positions in the cycle or wave. Similar to ripples or waves produced by dropping two stones in water. Length of sound wave varies with frequency. Low frequency equals longer wavelengths.

1 Introduction

Royal HaskoningDHV was commissioned to undertake the environmental noise specialist studies to determine the potential noise impact on the surrounding environment from the planned renewable solar power generation facility located on the farm called “Sand Draai 391”, located in the !Kheis Local Municipality forming part of the Siyanda District Municipality of the Northern Cape Province.

This report will assess the potential noise impact from all noise sources associated with the parabolic trough solar technology proposed at Sand Draai farm on the receiving environment. This assessment will highlight the existing noise conditions and character of the region, describe the methodology followed, list all noise sources and their associated sound power levels, describe different scenarios under investigation and conclude on the cumulative impact and recommendations to be investigated and implemented by the client.

This full impact assessment report propagates on the previous scoping assessment. The scoping phase is the environmental assessment stage of a project where issues are determined that should be addressed at subsequent stages (these can include impacts and preliminary alternatives). The scoping assessment recommended that a full impact assessment must be conducted based on the size of the project and the relative existing noise characteristics of the region. The report also listed different suggested scenarios to be assessed and indicated details pertaining to the meteorological conditions to use during the modelling and calculations of future noise scenarios.

The impact assessment will determine the most favourable location of the two alternatives provided to investigate for the location of the parabolic trough solar technology. The supporting infrastructures associated with the technology will also be discussed in the report to provide a cumulative noise impact.

1.1 Study Area Locality

The farm called Sand Draai 391 is located in the Northern Cape Province and is located south from the town of Upington and west from Kimberley. The region is classified as semi-arid and experiences a very low rainfall throughout the year. The region is sparsely populated with the population density increasing towards the small towns and cities in the region. The majority of the land uses are farms, ranging from small hectares of vineyards (close to the Orange River) to vast open areas for goat and sheep farming (located away from the river and in the semi-arid regions).

The closest town centre to the project area is the town of Groblershoop (28°53’38.39’’S 21°59’03.20”E), connected to Upington via the National highway N10 (~110km north). The Sand Draai farm is located on the eastern side of the Orange River passing the town of Groblershoop and the banks of the Sand Draai farm. The local road network to the site is gravel roads and is currently used by the construction vehicles of the Bokpoort Photovoltaic (PV) site.

1.2 Project Description

In parabolic trough technology, glass mirrors are most commonly shaped into the curved parabolic reflectors (troughs) (Figure 1). Parabolic troughs are usually designed to track the sun along one axis. An absorber tube containing HTF is situated along the focal line of the parabolic trough (Figure 2).

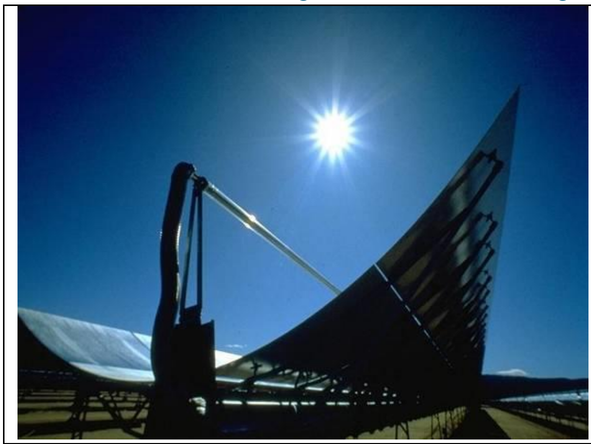	
Figure 1: Photo of a trough system[1]	*Figure 2: An absorber tube*[2]

The configuration of a parabolic trough CSP plant with storage is shown in Figure 3 as an example. The oil is heated to approximately 390°C in the solar field and then circulated through a series of heat exchangers to produce steam (e.g.: 100 bar in Andasol-1, 50 MW, Spain). The steam is converted to electrical energy in the power block, which consists of a conventional steam turbine generator and its associated cooling mechanism.

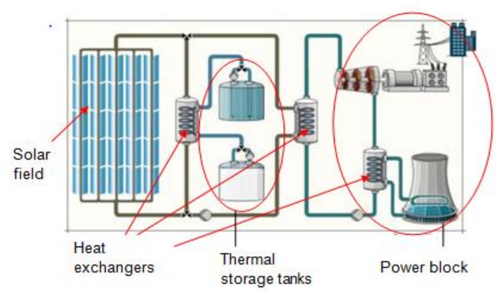	
Figure 3: An example of a parabolic trough power plant with storage	*Figure 4: Plant view of parabolic trough plant*[3]

[1] *http://www.energylan.sandia.gov*
[2] *TREE (Transfer Renewable Energy & Efficiency) seminar. (2009). Seminar material. March 18-20.*
[3] *http://www.renewables-made-in-germany.com/en/corporate-news/detail/article/ultimate-troughR-the-next-generation-collector-for-parabolic-trough-power-plants-first-demonstra.html*

1.3 Full Impact Assessment's Objectives

SANS 10328:2008 "Methods for environmental noise impact assessments" document defines the scope of work to assist in completing a full impact assessment, below are some key aspects that make up a full impact assessment:

- To determine and describe the existing noise climate of the study area where the development will take place;
- To identify all existing noise sources in the study area that potentially could have an impact on the noise levels;
- To identify all sensitive receptors and developments in the study area;
- To list all the possible noise causing equipment and processes that could be introduced by the new development in the region. Also estimate the Sound Power Level of the different equipment and/or processes;
- To indicate and describe the different scenarios and processes under investigation;
- To present all assumptions made during this assessment;
- To assess the noise propagation per scenario over the study area and to determine the difference in noise level;
- To rate the risk to the environment per scenario and/or operation activity;
- Conclude and recommend remedial measures or abatement technology that should be implemented, if found required; and
- To recommend future follow up investigations.

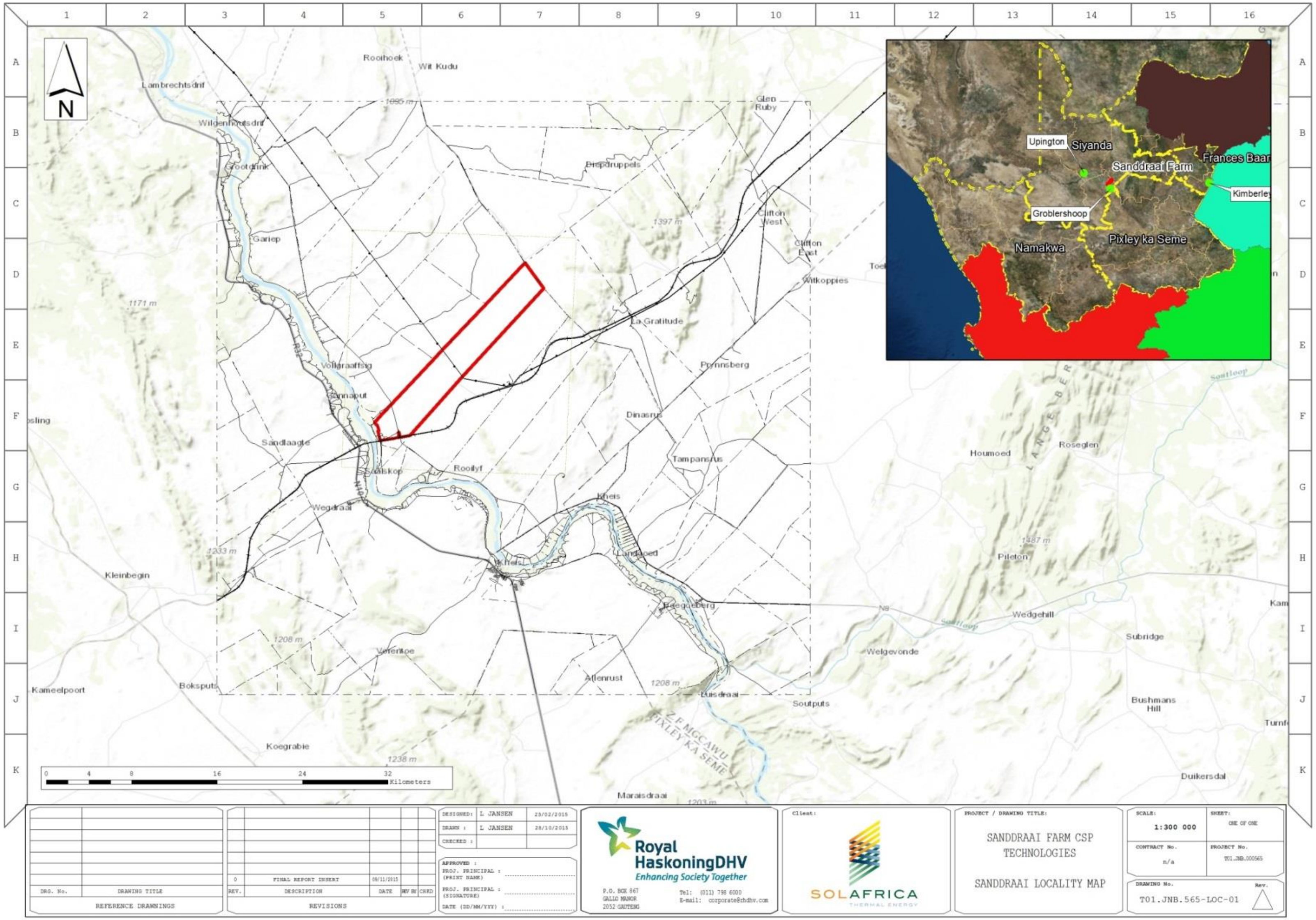

Figure 5: Locality Map of the study area and site location within South Africa

2 Project Applicable Legislation

In South Africa the Environment Conservation Act, 1989 (Act No. 73 of 1989) (ECA) has been superseded by the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) (as amended). However, the "noise control" regulations (on which SABS 0328:2000 was based) that were promulgated under sections 25 and 28 of ECA, and published in Government Notice No. GR 896 of 27 April 1990, will stay in force for the time being. The National Noise Control Regulations were adopted in 1998 by the different provinces and falls within the National Environmental Management Act.

The SANS 10328 standard forms the basis on which noise impact investigations should be conducted as prescribed in regulations published under the ECA, NEMA and the Environmental Management Air Quality Act, 2004 (Act No. 39 of 2004) (NEMAQA) or any other noise control regulations. In terms of the NEMA, an environmental impact study and assessment have to be conducted before a new development or upgrade of an existing activity can be approved by the relevant authority.

The environmental impact investigation has to:

- identify all the issues that could have an effect on the environment,
- assess the impact of the identified issues on the environment, and
- identify possible alternatives and assess their impact on the environment.

Noise is an issue that has a significant effect on the environment and its inhabitants' behaviour and should therefore form part of all environmental impact studies. However, contrary to most of the other environmental issues that are assessed subjectively, the assessment of the impact of noise on the environment can be done scientifically and objectively by following the procedures and methodology described in the SANS 10328 document (See Section 3). The reaction responses to noise on the other hand are subjective as each person can preserve noise in a different way.

The following subsection will discuss the different regulations that are relevant to this project and will conclude with a summarised table indicating the target noise levels.

2.1 Noise Control Regulations

As mentioned above, the National Noise Control regulations were promulgated in 1992, thereafter the provinces of South Africa adopted and instituted the provincial noise by-laws.

In terms of Regulation 2 (d) of the Noise Control Regulations:

> *"A local authority may, before changes are made to existing facilities or existing use of land or buildings, or before new buildings are erected, in writing require that noise impact assessments or tests be conducted to the satisfaction of the local authority by the owner, developer, tenant or occupant of the facilities, land or buildings and that reports or certificates relating to the noise impact be submitted to the local authority, to the satisfaction of the local authority, by owner, developer, tenant or occupant."*

In terms of Regulation 3 (c) of the Noise Control Regulations:

> *"No person shall make changes to existing facilities or existing use of land or buildings or erect new buildings, if these will house or cause activities that will, after such changes or erection, cause a disturbing noise, unless precautionary measures to prevent the disturbing noise have been taken to the satisfaction of the local authority."*

In terms of Regulation 4 of the Noise Control Regulations:

> *"No person shall make, reduce, or cause a disturbing noise, or allow it to be made, produced or cased by any person, animal, machine, devise or apparatus or any combination thereof."*

2.2 South African National Standards (SANS)

In the absence of national promulgated standards for environmental noise, the South African Standards Act (Act 8 of 2008) ensures that, although there are no legal standards as such, the applicable SANS documents and guidelines are enforceable until national legislation is published.

Thus it is important that the following SANS documents and their contents be followed and adheres to ensure compliance on the aspect of Environmental Noise. A summary list of applicable SANS documents regarding environmental noise is:

- SANS 10328:2008 "Methods for environmental noise impact assessments";
- SANS 10103:2008 "The measurement and rating of environmental noise with respect to annoyance and to speech communication"
- SANS 10357:2004 "The Calculation of sound propagation by the CONCAWE method"
- SANS 10210:2004 "Calculating and predicting road traffic noise"
- SANS 10117:2008 "Calculation and prediction of aircraft noise around airports for land use purposes"
- SANS 13474:2012 / ISO 13474:2009 "Acoustics – Framework for calculating a disturbance of sound exposure levels for impulsive sound events for the purposes of environmental noise assessments"

2.2.1 SANS 10328:2008

The project will follow the methodology set out in SANS 10328:2008 "Methods for environmental noise impact assessments". This SANS document prescribes the methodology to follow for the three main impacts assessment reporting stages - screening, scoping and full impact assessment.

This project will be assessed as a full impact assessment as the size and type of project will require a conclusive investigation and accurate modelling. The method applied is discussed in section 3.

2.2.2 SANS 10103:2008

SANS 10103 should also be adhered to for the measurements of noise levels at specific locations. This document prescribes the methodology of how a noise investigation should be conducted and prescribes the selection of monitoring locations, placement of the microphone and specific equipment and calibration of the equipment. To accurately determine if a noise level from the field is compliant to the maximum allowed noise rating level, specific calculation formulas and methods are detailed in the SANS document. The typical "straight forward" comparison of the L_{Aeq} value (read directly form the SLM) is not equal to the L_{AReq} (rating level as calculated) which is listed in Table 1, below.

Only in special cases or where the sound generated from a specific activity or equipment need to be evaluated, can this be done, however an expert must be advised on directly comparing the value to the regulation.

Table 1: Typical rating levels for noise in districts (adapted from SANS 10103:2008)

Type of District	Equivalent Continuous Rating level for Noise ($L_{Req,T}$) (dBA)					
	Outdoors			Indoors (with windows open)		
	Day/Night ($L_{Req,dn}$)	Day ($L_{Req,d}$)	Night ($L_{Req,n}$)	Day/Night ($L_{Req,dn}$)	Day ($L_{Req,d}$)	Night ($L_{Req,n}$)
a) Rural	45	45	35	35	35	25
b) Suburban (with little road traffic)	50	50	40	40	40	30
c) Urban	55	55	45	45	45	35
d) Urban (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 District	70	70	60	60	60	50

Table 2: Categories of community/group response (adapted from SANS 10103:2008)

Excess ($\Delta L_{Req,T}$)[a] dBA	Estimated Community/Group response	
	Category	Description
0 – 10	Little	Sporadic Complaints
5 – 15	Medium	Widespread Complaints
10 – 20	Strong	Threats of community/group action
>15	Very Strong	Vigorous community/group action

NOTE: Overlapping ranges for the excess values are given because a spread in the community reaction might be anticipated.

a. $\Delta L_{Req,T}$ should be calculated from the appropriate of the following:

1) $L_{Req,T}$ = $L_{Req,T}$ of ambient noise under investigation MINUS $L_{Req,T}$ of the residual noise (determined in the absence of the specific noise under investigation);
2) $L_{Req,T}$ = $L_{Req,T}$ of ambient noise under investigation MINUS the maximum rating level of the ambient noise given in Table 1 of the code;
3) $L_{Req,T}$ = $L_{Req,T}$ of ambient noise under investigation MINUS the typical rating level for the applicable district as determined from Table 2 of the code; or
4) $L_{Req,T}$ = Expected increase in $L_{Req,T}$ of ambient noise in the area because of the proposed development under investigation.

2.3 Summary of Target Noise Levels

It should be noted, that in the different guidelines and standards, listed above, the impact from noise could be calculated on different “type” of equations and formulas. In SANS 10328 the impact is derived from the change of the future noise levels and the typical rating noise level for the receptor (maximum permissible noise level as identified in Table 1). This type of impact can be described as the noise impact, however this excludes the baseline of the region that would impact on the cumulative noise levels.

The other “type” of calculation is based on the change in noise level estimated at the receptor (as found in Table 2). This calculates the change in noise level experienced by the receiver at a location. It binds with the theory of noise, which states, that any +3dBA change in noise level is a doubling of the noise sources. Thus it should be noted, that there are different categories from different institutions regarding this aspect of environmental noise.

Table 4 includes a summary of the environmental impact rating (regarding severity), as measured at the closest applicable receptor point. The outdoor (environmental) noise levels are the basis for the calculation perceived at the receptors. It is noted that the majority of complaints arise from residents during the night, these types of complaints are more characteristic to indoor noise levels. If any of the receptors’ night-time noise levels are exceeded, a calculation of the perceived indoor noise will be done.

Based on the alternative sites’ locality (in the rural areas of the Northern Cape Province with a sparse population density at the area of interest) the typical noise level rating (also referred to as the maximum allowable noise level) for the study is classified as Rural, unless specified otherwise by the receiver. It should be noted once the solar facility is in operation the land use zoning of the section of farm will be reclassified to Industrial within the boundaries of the farm.

Table 3: Typical Rating Noise Level for this assessment

Equivalent continuous rating noise level (L_{Req})	Outdoor			Indoor		
	Day/Night ($L_{Req,dn}$)	Day ($L_{Req,d}$)	Night ($L_{Req,n}$)	Day/Night ($L_{Req,dn}$)	Day ($L_{Req,d}$)	Night ($L_{Req,n}$)
(A) Rural	45	45	35	35	35	25

Table 4: Environmental Impact Rating from the change in noise level

<table>
<tr><td>Δ +15 dBA</td><td rowspan="5">Strong Response
“Threats of Community Action”</td><td rowspan="12">Significant</td><td rowspan="9">Disturbing noise</td><td rowspan="5">Very High</td></tr>
<tr><td>Δ +14 dBA</td></tr>
<tr><td>Δ +13 dBA</td></tr>
<tr><td>Δ +12 dBA</td></tr>
<tr><td>Δ +11 dBA</td></tr>
<tr><td>Δ +10 dBA</td><td rowspan="5">Medium Response
“Widespread Complaints”</td><td rowspan="3">High</td></tr>
<tr><td>Δ +9 dBA</td></tr>
<tr><td>Δ +8 dBA</td></tr>
<tr><td>Δ +7 dBA</td><td rowspan="2">Medium</td></tr>
<tr><td>Δ +6 dBA</td><td rowspan="6">Not Disturbing</td></tr>
<tr><td>Δ +5 dBA</td><td rowspan="5">Little Response
“Sporadic complaints”</td><td rowspan="2">Low</td></tr>
<tr><td>Δ +4 dBA</td></tr>
<tr><td>Δ +3 dBA</td><td rowspan="3">Insignificant</td><td rowspan="3">Very Low</td></tr>
<tr><td>Δ +2 dBA</td></tr>
<tr><td>Δ +1 dBA</td></tr>
<tr><td>Change in Noise level</td><td>SANS 10103</td><td>WHO (IFC EHS Section 1.7)</td><td>***Disturbing noise (Noise Control Regulations)</td><td>Environmental Impact Rating (Severity)</td></tr>
</table>

** It should be noted that the WHO is only applicable to the closest receptor to the source, located offsite from the source.*
*** The environmental impact rating level will be used to determine the severity of the impact.*
**** It should be noted that this form of describing a noise as disturbing was removed from the majority of provincial noise regulation by-laws.*

3 Project Methodology

The general procedure to follow impact assessments regarding noise on the environment are outlined in SANS 10328:2008 “Methods for Environmental Noise Impact Assessment”. As per agreement with the client, this report focuses on the full impact assessment (Section 8 in SANS 10328). The investigation will address the key points as listed in section 8.7, following additional procedures and protocol listed in SANS 10103 and the noise control regulations.

As the report follows upon the scoping report completed in 2014, the methodology will focus on the following sub-categories.

- Determination of the sound emission from identified noise sources
- Determination of the expected rating level
- Determination of the desired rating level
- Determination of the noise impact
- Assessment of the noise impact
- Alternatives and mitigation measures

The following methods focuses on determining the existing sound power levels of all existing sound sources in the region and also to estimate the sound power levels of all equipment/activities/operations of the new development. These SPLs will be used in the propagation model (CadnaA) to calculate the noise levels at each receptor point. Different mitigation measures can be investigated to reduce noise at identified receptors.

The noise impact assessment will include the following scenarios, as suggested by the scoping report:

- Scenario 01: Baseline
- Scenario 02: Construction Phase
- Scenario 03: Operational Phase
- Scenario 04: Cumulative Impact
- Scenario 05: Mitigated Operational Phase (*if found required*)

3.1 Determination of sound emissions from identified sources

In determining the sound power levels (SPL) of the existing and future noise sources, an in-depth investigation was conducted on all equipment used to assess their pattern and cycle of operation, placement of sources, spectral character of each source and number of sources.

A full sound power level inventory is presented in Section 6, where each scenario’s SPL inventory will be indicated.

3.2 Determination of the desired rating level

During the site visit to the Sand Draai Farm, long term daytime measurements were conducted at the northern centre location of the farm and short term noise survey’s were completed at points in the area. The results of these locations were used to determine the desired rating level for the surrounding regions. The calculations followed SANS 10357 and SANS 10103.

The desired rating levels are presented in Table 5.

4 Existing Environment

The following section, present the results of the site visit at the Sand Draai farm during the scoping assessment and described the sound profile of the region. In the subsections the existing noise sources, identified sensitive receivers and meteorological summary of the region are described to provide the reader with the setting of the region and the potential of sound propagation.

The short- and long-term noise monitoring was conducted during 28th to 30th September 2014. The monitoring as conducted following the methodology set out in the SANS 10103 document. The short-term noise monitoring was conducted over a period of no less than 15 minutes and some extended to a period of 60 minutes. The long-term monitoring was conducted over a set period of 24 hours. The parameters measured and calculated from the data are:

- LAeq - It is common practice to measure noise levels using the A-weighted setting built into all sound level meters. This is a summary noise level recorded over the exposed period of time, the term is also called Equivalent Continuous Sound Level.
- LCeq – An additional function of integrated sound level meters are to measure the sound through a C-weighted filter, this term is similar to the LAeq but focusses more on the lower frequency sounds.
- LAeq,day/night and day-night – This term present the whole 24hour equivalent continuous sound level recorded by the sound level meter in the A-weighted band.
- LA10 - is the noise level just exceeded for 10% of the measurement period, A-weighted and calculated by Statistical Analysis.
- LA90 is the noise level just exceeded for 90% of the measurement period, A-weighted and calculated by Statistical Analysis.

The short term measured results are listed in the following table (see Figure 8) and descriptions of the noise experienced at the location are provided. As the area is located in a remote rural region and there is no major noise sources located close to the site and no night-time short measurements were made, the night-time noise profile of the area is covered by the long-term noise measurement.

Table 5: Baseline Noise Level Results including desired rating level

Site_ID	Name	Latitude	Longitude	Daytime (LAeq) sound level	SANS 10103 Rural Limit
SD 01	Sand Draai Gate	-28.778700°	21.903110°	70.1	45
SD 02	Bokpoort - Rooilyf Station	-28.744976°	21.981758°	51.6	45
SD 03	Eskom Substation	-28.740887°	21.994887°	58.7	45
SD 04	North from Bokpoort	-28.708600°	22.027500°	46.6	45
SD 05	Sand Draai Route 01	-28.761100°	21.917030°	44.4	45
SD 06	Sand Draai Route 02	-28.736084°	21.934172°	21.5*	45
SD 07	Sand Draai Route 03	-28.713362°	21.956478°	20.3*	45
SD 08	CSP South Area	-28.688778°	21.981276°	24.1*	45
SD 09	CSP North Area	-28.653102°	22.012477°	20.7*	45
SD 10	N10	-28.884922°	21.964554°	70.9	60
SD 11	N8	-28.850011°	22.031312°	69.6	60
SD 12	Gariep Road	-28.835281°	21.986093°	61.2	60
SD 13	Bokpoort Residence	-28.73776°	21.97593°	31.8	45
SD 14	Bokpoort Site fence line, south	-28.73397°	22.00043°	46.1	45

** values refer to the L_{Amin} value due to the wind interference.*

The description per monitoring point is detailed on the following page.

- SD01: The rock breaker that was used to dig a hole for the water pipeline to Bokpoort influenced the noise recording at the location. The machinery also travelled across the road and is not a true representation of the natural background of the area.
- SD02: The location is along the road towards the Bokpoort site and was impacted by construction vehicles passing the location.
- SD03: At the location, the substation noise was audible together with road traffic noise of construction vehicles. During the measurement a train stopped at the Rooilyf station.
- SD04: Close to the Oryx Reserve, located north from Bokpoort, the train started to move and was audible as it passed the location.
- SD05: Sand Draai farm property - the location is in the first camp of the farm along the main road.
- SD06: Sand Draai farm property - the location is in the second camp of the farm. The wind did impact noise levels and is suggested that the L_{Amin} levels be used.
- SD07: Sand Draai farm property - the location is in the third camp of the farm. The wind did impact noise levels and is suggested that the L_{Amin} levels be used.
- SD08: Sand Draai farm property – monitoring point is located south of the planned CSP field. The wind did impact noise levels and is suggested that the L_{Amin} levels be used.
- SD09: Sand Draai farm property - the monitoring point is located north and in the field of the planned Parabolic troughs. The wind did impact noise levels and is suggested that the L_{Amin} levels be used.
- SD10: Traffic noise measurement – recording should be used to calculate and determine the road sound power level.
- SD11: Traffic noise measurement – recording should be used to calculate and determine the road sound power level.
- SD12: Traffic noise measurement – recording should be used to calculate and determine the road sound power level.
- SD13: Train passed along the tracks, was audible. Generally quite, no construction noise audible.
- SD14: Construction site noise, rock breaker active breaking rock, about 400m away. Closest construction noise is 150m away.

The results of the long-term noise monitoring indicates there were some wind interference during the day-time, once the wind subsided during the night the sound profile is more constant and reliable. Table 6 present the results of the long-term measurement.

Table 6: Long-term noise measurement results – Sand Draai farm

Parameter	Result / Detail	
Start Date and Time	2014/09/30 15:56	
Duration	24 hours	
Location	-28.653739	22.011702
LAeq	42 dBA	
LAmax (with date and time)	79.4 dBA	2014/10/01 11:38
LAmin (with date and time)	18 dBA	2014/09/30 21:09
LReq,day	47.99 dBA	
LReq,night	38.33 dBA	
LReq,day/night	48.11 dBA	

Table 7 below present a summary of the 1/3 octave band levels (complete 1/3 graph can be made available on request), in the form of a 1/1 octave band level, differentiating between day, night and day/night levels. This will provide a clear indication of the existing sound scape of the region also illustrate the difference between the day and night profile.

Table 7: Octave band – long-term results summary – A-Weighted (dBA)

	16 Hz	32 Hz	64 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	16 k Hz
Day/Night	18.5	29.4	35.6	34.8	31.3	29.2	30.6	31.4	32.7	29.4	25.3
Day	3.0	14.0	20.3	19.5	16.1	14.0	15.4	16.1	17.5	14.0	9.7
Night	-3.9	6.8	10.9	9.0	5.0	2.9	4.5	7.4	7.4	6.7	3.9

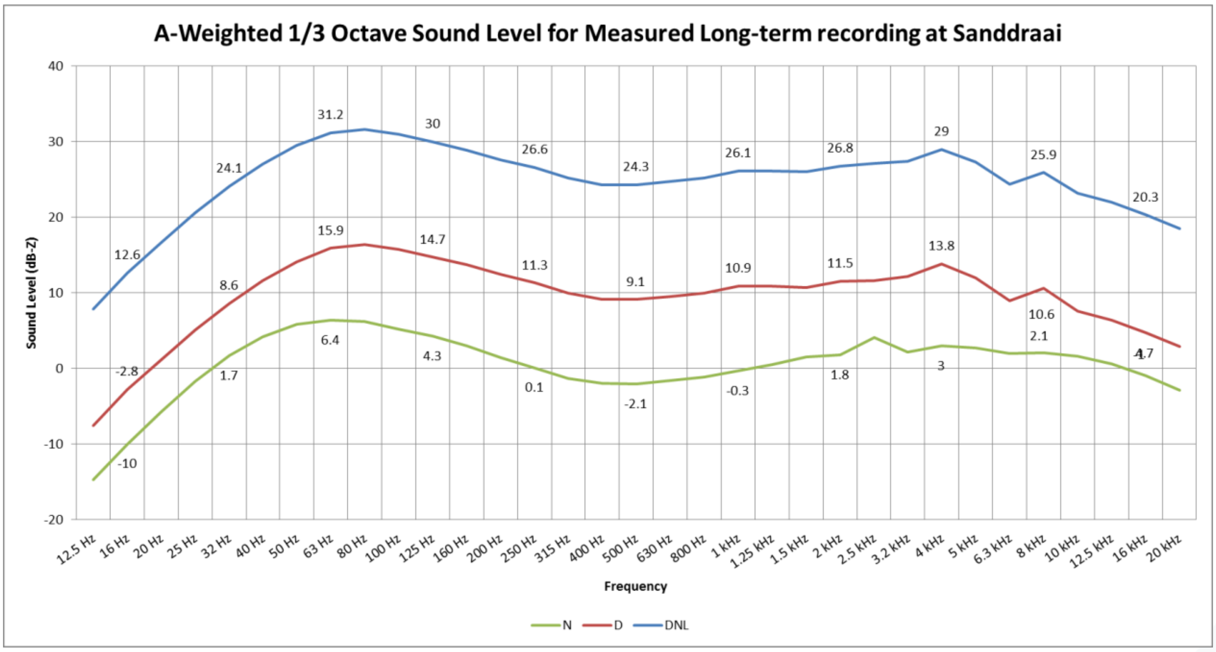

Figure 6: Baseline 1/1Octave Graph at Sand Draai Farm (N= Night; D= Day & DNL= Day/Night (24hours))

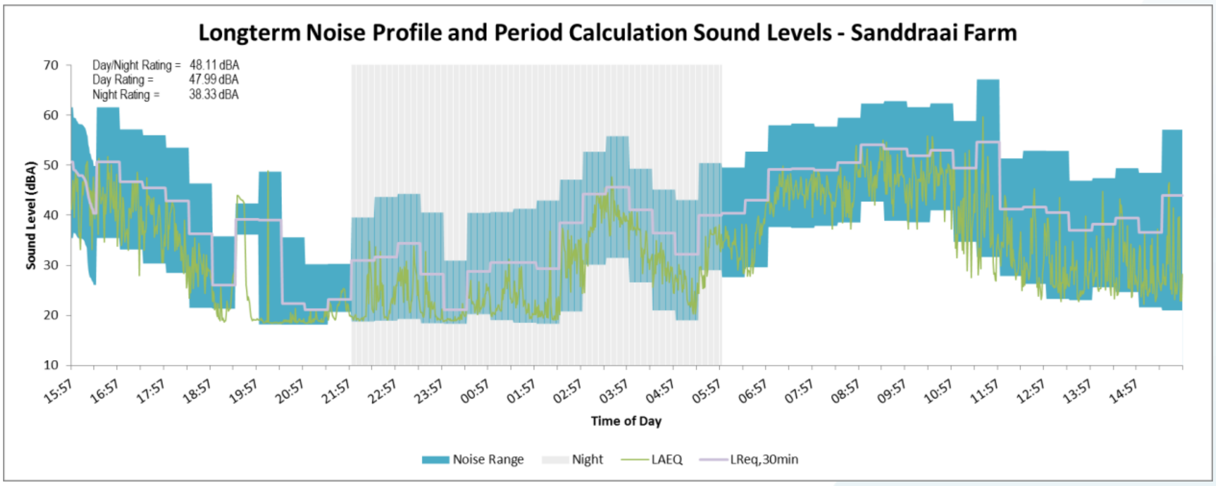

Figure 7: Long-term noise profile at Sand Draai Farm

4.1 Existing Noise Sources

The assessment found some sources of noise in the existing environment that could be calculated and modelled in the propagation software. Other sources such as wildlife, birdcalls, insect noise, are excluded from the calculation in the baseline.

4.1.1 Roads

Roads in the region identified to be included in the soundscape are:

- National Route 10 (N10) – The road travels from Groblershoop to Upington all along the banks of the Orange River. The road has a large number of small vehicles.
- Unnamed Road 01 (Road turning off from N8) – This gravel road is the main access route to the site and is currently utilised by all the construction vehicles travelling to Bokpoort.
- Unnamed Road 02 (access road to Bokpoort) – turning off from the main access road, across the bridge over the rail way is a service road following the railway line, this road also is used as the main access road to Bokpoort.

4.1.2 Railway line

The Saldanha-Sishen railway line is aligned in a north-east to south-west direction through the central sector of the neighbouring farm Bokpoort (the farm on which the Bokpoort plant is undergoing construction). There is a cross-over siding (Rooilyf Siding) for the ore trains just south of the location of Bokpoort (Loop 16). There are 3 trains per day on this line (data obtained from Transnet Freight Rail) the speed of the train travelling is no more than 50km/hr.

4.2 Identified sensitive receptors

Figure 8, indicates the sensitive areas, based on the information gathered from cadastral maps (2821DB, 2821DD, 2822CA & 2822CC), Google Earth and other Aerial Photography conducted in the past. It is noted that some of the information is old and that houses could have been constructed recently. The sensitive areas were established to the best available information at hand and experience gained during the site visit.

As these areas are spread out over the region, therefore there are only a few sensitive areas located close to the boundary of the farm. Table 8, below, present the relevant sensitive areas selected for detailed analysis.

Table 8: List of receivers (sensitive areas) used in the modelling for analysis

Site_ID	Name	Latitude	Longitude	SANS 10103 Maximum allowable noise limit (dBA)		
				Day Night (24 hour cycle)	Day (06:00 – 22:00)	Night (22:00 – 06:00)
REC_01	Sand Draai farm gate	-28.7787	21.90311	45	45	35
REC_02	Eskom substation	-28.740887	21.994887	45	45	35
REC_03	Loop16 North	-28.7086	22.0275	45	45	35
REC_04	Sand Draai North	-28.653739	22.011702	45	45	35
REC_05	Bokpoort farmhouse	-28.73776	21.97593	45	45	35
REC_06	Bokpoort contractors offices	-28.73397	22.00043	45	45	35

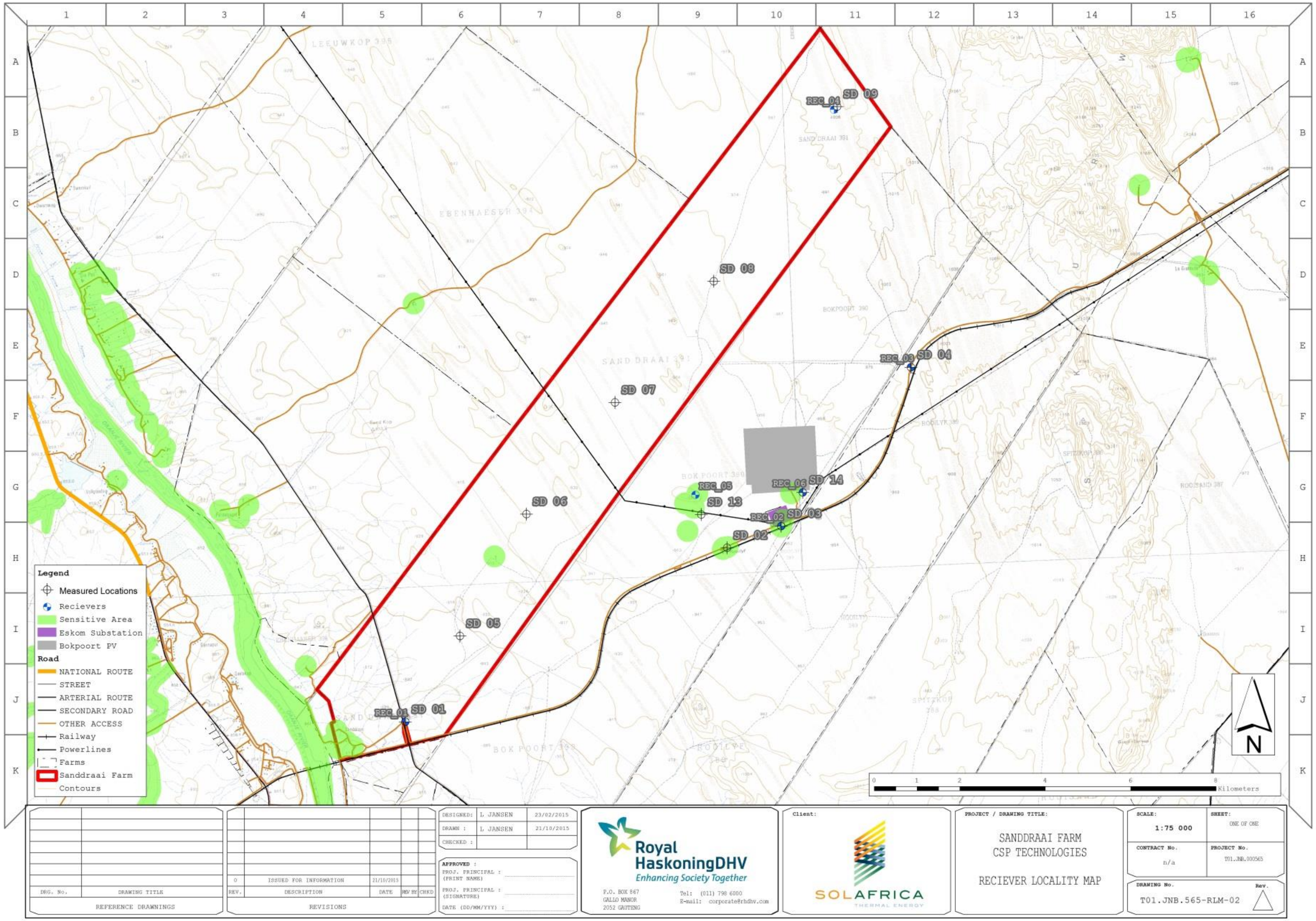

Figure 8: Map illustrating the locations of the identified receptors to be used in the full impact assessment

4.3 Regional Existing Meteorological Conditions

As the area is a semi desert area, the temperature will fluctuate largely during the day and night and from season to season. The province has very sparse rainfall (ranging between 50 and 400mm per annum). The typical summer day-time temperature is in the range of 34°C to 40°C, often exceeding the 40°C mark in summer. The winter days are warm and the nights are very cold. The formation of dew and frost supplement the low rainfall in the region, with plant specifically adapted to capture as much moisture as possible. The formation of snow on mountains, are possible during very cold winter days.

The closest South African Weather Services station for the Sand Draai farm is the Upington Station (UPINGTON WO), approximately 75km, north west from the Sand Draai farm. The environment at the Upington weather station is similar to the environment at Sand Draai and the data from the station is appropriate for this assessment. Three years (2011 – 2013) historical hourly data was analysed and the average year (average from the three years) are presented in Table 9.

Table 9: Average Year (2011-2013) meteorological summary table

	Temperature Average	Temperature Max	Temperature Min	Rainfall	Cloud Cover	Atmospheric Pressure	Humidity	Wind Speed	Wind Direction
	°C	°C	°C	mm	tenths	mbar	%	m/s	° from north
January	28.8	36.7	20.7	38.5	3	916.3	33.7	3.6	231.9
February	26.9	34.6	19.5	77.6	4	917.5	44.0	3.3	299.2
March	25.8	33.8	18.1	70.9	3	919.1	40.4	3.2	296.0
April	19.7	28.0	12.0	25.1	3	922.3	46.9	3.0	5.8
May	15.8	24.9	8.4	12.1	2	923.7	47.3	3.2	339.4
June	11.4	20.6	4.2	17.3	2	925.2	51.7	3.1	335.9
July	11.2	20.5	3.7	6.7	2	926.6	49.4	2.9	338.8
August	13.4	22.7	5.0	1.3	2	923.7	39.3	3.5	288.2
September	17.2	26.9	7.7	0.4	1	923.1	28.6	3.3	248.9
October	21.3	30.0	12.2	7.5	2	920.1	25.7	3.7	231.3
November	25.0	33.8	15.6	6.7	2	918.4	22.4	3.9	229.9
December	26.6	34.5	18.7	36.1	3	917.6	35.0	4.0	242.9
Annual Average	20.3	28.9	12.2	300.1	2.4	921.1	38.7	3.4	286.3
Winter Average	16.2	25.1	8.6	133.4	2.3	923.4	45.8	3.2	327.6
Summer Average	24.3	32.8	15.7	166.7	2.5	918.8	31.6	3.6	246.2

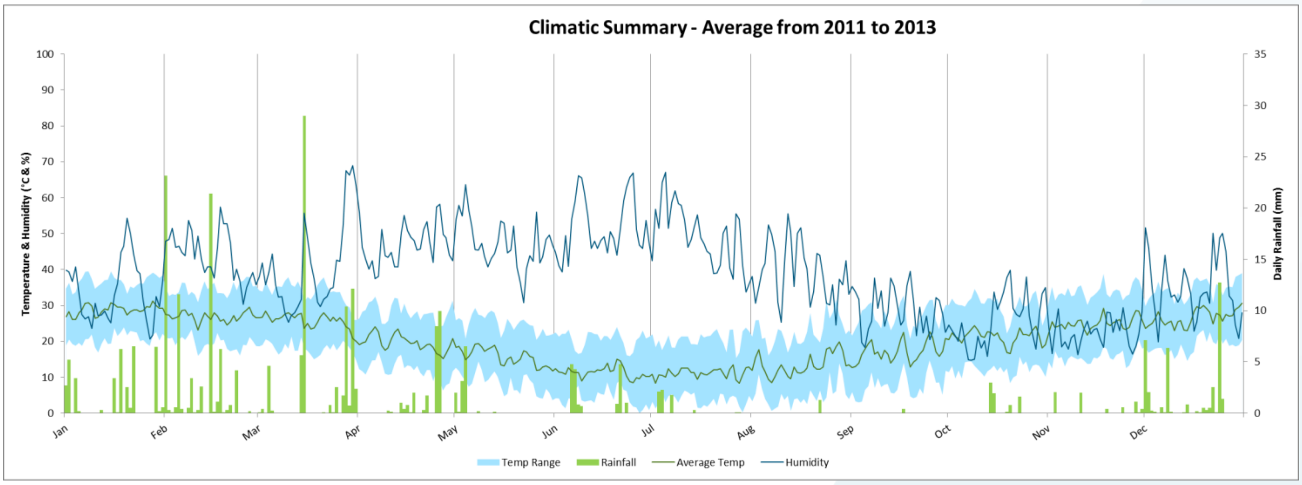

Figure 9: Climatic Summary for Upington WO for 2011-2013

Figure 10: Upington Wind Rose summary 2011 – 2013

5 Propagation Model Data Input & Assumptions

This section provides the details regarding the input parameters used to setup the sound propagation modelling software. The input required ranges from terrain, calculation area, meteorological, SPL, etc.

The future estimation of noise levels in the region will be calculated by the approved international modelling software called CadnaA, the environmental noise modelling software used by Royal HaskoningDHV (South Africa). The software is an international leading package for calculation, presentation, assessment and prediction of environmental noise. The CadnaA software is designed to handle all types and sizes of projects; determining the noise from an industrial plant, a parking lot, noise emanation from buildings, a new road or railway network and entire towns and urbanized areas. The software is designed with more than 30 international standards and guidelines (with the option to add local standards and guidelines), powerful calculation algorithms, extensive tools for object handling and an outstanding 3D visualization tool. The CadnaA software can communicate with other Windows applications like word processors, spreadsheet calculators, CAD software and GIS-databases. The data that was entered into the model are, but not limited to the following:

- Topography;
- Meteorological conditions;
- Roads;
- Buildings;
- Noise point sources;
- Line noise sources (HP pipes, etc.); and
- Area sources, like construction activities (horizontal and vertical);

5.1 Project Study Area

As mentioned before the study area falls over four topographical grids called (2821DB, 2821DD, 2822CA & 2822CC), the contour height lines of each was merged and one final contour line file was created and clipped to the project calculation area boundaries. The contours were then imported into CadnaA to set the base heights for the model. Table 10 indicated the SW and NE corner coordinates of the project area and calculation area used in CadnaA.

Table 10: Project and Calculation Area coordinates

		Latitude	Longitude	X-coordinate (UTM 35S) - meters	X-coordinate (UTM 35S) - meters	Area Size (km²)
Project Area	SW NE	-28.809 -28.616	21.855 22.053	-2444.9 16021.3	6802333.7 6824580.6	410.8

5.2 Configuration

In SANS 10328 and SANS 10103 it is stated that the SANS 10357 (CONCAWE method) and SANS 10210 (Calculation of Road Traffic Noise) must be used to assess the propagation of sound for the purpose of impact assessments. The CadnaA modelling software has a list of international calculation methods, from this the CONCAWE was selected for industrial purposes (normal propagation method from source to receiver) and CRTN for road calculations. The CRTN is a Welsh and UK preferred method, on which the SANS 10210 is strongly based. Similar to the CRTN the CRN method was chosen for the calculation of railway noise.

Each of the calculation methods has specific options to select to ensure the method of calculation is done in the correct way and is acceptable on the project. The one option of different time intervals used to calculate, refers to the day/night time frames and excluded evening hours in a day. Thus the daytime (06:00 – 22:00) has 16 hours and night-time (22:00 – 06:00) has 8 hours (16/0/8).

The whole of the evening was also excluded from calculations and no hours of operation was specified for this period during a day. If activities are only operational for a set period of time during the day and/or night, it will be specified within the source.

The model was programed to calculate the Day-, Night and Day/Night rating levels (dBA) in octave band frequencies and a final single band value. The results will be calculated per receiver and can be directly evaluated against the SANS 10103 maximum allowable rating levels. The results (iso-decibel lines and table format) was exported for further analysis and investigation. The calculation grid was setup with a 50m x 50m spacing and a height above ground level of 1.5m.

5.3 Metrological Data

The meteorological parameters required for the use in this study are: Temperature, Humidity, Wind Speed, Wind Direction and Atmospheric Stability Class.

The meteorological data discussed in Section 4.3 covered the records from 2011 to 2013. The meteorological settings built in provide limited options for Temperature and Humidity. The average data was used in the model, equating to an annual average for the parameters.

Table 11: Meteorological Input data

Parameter	Daytime (06:00 – 22:00	Evening (n/a)	Night (22:00 – 06:00)
Temperature			
- *Average*	20.24	---	20.16
- *Maximum*	44.4	---	41.9
- *Minimum*	-3.80	---	-3.4
- *Model input (CadnaA)*		20	
Humidity			
- *Average*	32.1	---	52.1
- *Maximum*	99.0	---	98.0
- *Minimum*	2.0	---	8.0
- *Model input (CadnaA)*		55*	
Wind Profile			
- *Atmospheric Stability Class*	C	---	F
- *Wind Speed*	3.76	---	2.64
- *Wind direction*	270.5	---	313.7

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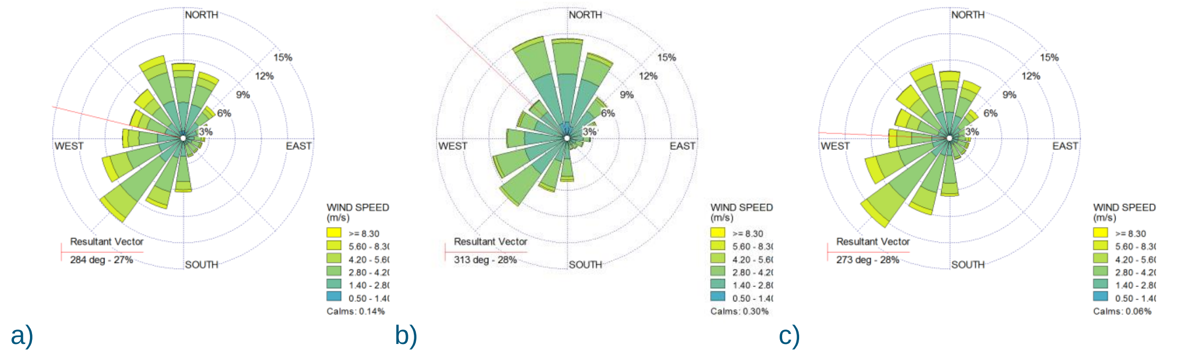

Figure 11: Wind roses from 2009-2012 data (a) Annual (24hours), b) Night-time (22:00 – 06:00) and c) Daytime(06:00 – 22:00)

5.4 Variant (Scenarios)

Within CadnaA all objects are organized in groups to assign the correct objects (sources, buildings, receptors, grids, etc.) to the associated scenario (variant).

The following list of scenarios are defined and were calculated in the model.

Table 12: Variant names description used in CadnaA

Short Name	Variant (Scenario) Name
BL	Baseline
CSP	Construction Phase
OCSP	Operational Phase
MIT	Mitigated Scenario *(if applicable)*

5.5 Limitations and Assumptions

No finalised designs of the plant were made available once the project commenced with the modelling of scenarios, thus the noise generated were applied to the area covered by the operations to represent a typical noise emitted from the boundaries of similar operations. The accuracy and impact accepted in real life may vary form the results and simulations presented in this report. It is proposes that a detailed modelled simulation be conducted once the final designs are made available together with the alternative access road and transmission line options.

No low frequency noise investigations or modelling could be preformed during this assessment, due to the available information, it is recommended that a follow-up study be completed once all information is gathered for this project to accurately ensure the propagation of noise and to investigate any tonal incidents that might occur.

The day, night and day/night values calculated by the model present the rating noise levels ($L_{Req,T}$) and can be directly evaluated against the SANS 10103 land-use values. However as this value is an all inclusive value it is viewed as a worst case scenario result.

The meteorological conditions used in the model is based on the analysis of the meteorological data set, local variances can occur that can influence the noise from source to receiver. Thus the typical meteorological data used is a representation of the likely conditions for the area. The noise profile can be different during short events.

6 Sound Power Level (SPL) Inventory

6.1 Scenario 01 – Baseline (Existing Noise)

This scenario focuses on determining the existing baseline noise levels at all receptors identified and measured during the site visit. The measurement done during the site assessment were used to calibrate the model and to discuss the existing soundscape of the region and site. The identified noise sources of the region were identified and basic measurements and observations were made to ensure the baseline conditions of the region are as accurate as it can be. It should be noted that the background noise can not solely be described to the identified and listed sources as the ambient noise is impacted by an accumulation of different noise sources. The list of applicable sensitive receptors are presented at the end of this SPL inventory. As there are minimal sources in the region, at some areas no sources were audible (only wind and wildlife) the baseline noise levels were set at 34.1 dBA, day and 28.5dBA, night (LA90 of 24-hour measurement [REC_04]). The values cited, represent the baseline conditions which could not be modelled, but is important to include in this project.

Table 13: Summary Sound Power Level Inventory – Scenario 01

SRC_CODE	NAME	SOURCE TYPE	SPL (dBA)	DURATION (min)	
				Day (06:00 -22:00)	Night (22:00 – 06:00)
ESB	Eskom Substation	Area	105.5	960	480
BPV	Bokpoort PV Complex	Area	115.8	540	0
RWL	Railway line	Rail	38.1	960	480
RDS	Roads	Road	45	960	480

6.2 Scenario 02 – Construction Phase

The construction phase of the Parabolic Trough Solar technology is presented in the following sources depicted below. The scenario will also investigate the difference in the two suggested alternative locations for the technology and will not include any of the additional infrastructures at this scenario, these will be addressed in the following scenarios.

The scenario consists of a construction camp, including offices, laydown areas, assembly points, etc. Also included and on a separate area of the allocated field is the construction of the power block. The noise sources associated with the construction is difficult to accurately calculate, as not all sources are active simultaneously and the majority of sources are mobile and active at different locations throughout the construction period. The construction is planned to start only during working hours and thus the shifts are modelled to start from 08:00 and end around 20:00

Table 14: Summary Sound Power Level Inventory – Scenario 02

SRC_CODE	NAME	SOURCE TYPE	SPL (dBA)	DURATION (min)	
				Day (06:00 -22:00)	Night (22:00 – 06:00)
CSP_CC	Construction Camp	Area	96.4	780	0
CSP_CT	Construction at Power Block	Area	107.4	780	0
INF_WR	Infrastructure	Line	92.4	260	0
INF_PL	Infrastructure	Point	103.1	90	0

6.3 Scenario 03 – Operational Phase

The scenario focusses on the operational noise generated by the operations of the parabolic trough, power block and associated infrastructures and operations. It should be noted that the exact position and layout of the parabolic trough design have not yet been finalised. There are several alternative candidate sites for the power block at both the alternative sites. However, the likely location of the power block with this technology is in the centre of the fields or on the outer perimeter of the site. Within this location the power block, turbine, auxiliary heating system, cooling fans, etc. will be located.

The remainder of the solar field contains the different parabolic trough mirrors and technology which must be kept clean with the washing vehicles, these vehicles will travel at a slow speed in between the mirrors to complete the washing cycle. The working staffs are likely to travel from the town to the site with their own vehicles. The operational time will be for the majority within the daytime timeframe, with an hour or two within the night-time time frame (before 06:00 during the summer months)

Table 15: Summary Sound Power Level Inventory – Scenario 03

SRC_CODE	NAME	SOURCE TYPE	SPL (dBA)	DURATION (min)	
				Day (06:00 -22:00)	Night (22:00 – 06:00)
OCSP_SF	Solar Field	Area	101	480	60
OCSP_PB	Power Block	Area	114.1	960	120
OCSP_ACR	Access Road	Road	50.3	---	---

6.4 Scenario 04 – Infrastructures

This scenario investigated the noise that will emanate from the construction of the ancillary infrastructures for the project (access road, power lines and water pipeline including water pumping station). Both alternatives locations (corridors) for the roads, power lines and water pipeline will be investigated together and the noise profile can be added together to the previous scenarios to estimate the construction phase noise impacts.

The noise sources associated with this stage of the construction is from heavy vehicles (earth scrappers, dozers, rollers, hauling trucks, etc.) - it is suggested that the roads to and from the site be tarred (paved) - the investigation will assume that the roads are unpaved to generate the worst case scenario regarding noise. The power lines noise sources will be similar to the road and water pipeline construction but will have a pile driving activity included.

Figure 12: Summary Sound Power Level Inventory - Scenario 04

SRC_CODE	NAME	SOURCE TYPE	SPL (dBA)	DURATION (min)	
				Day (06:00 -22:00)	Night (22:00 – 06:00)
INF_PL	Power lines	Point	103.1	90	0
INF_WR	Water pipelines and road	Line	92.4	260	0
INF_WP	Water pumping station	Point	95	510	0

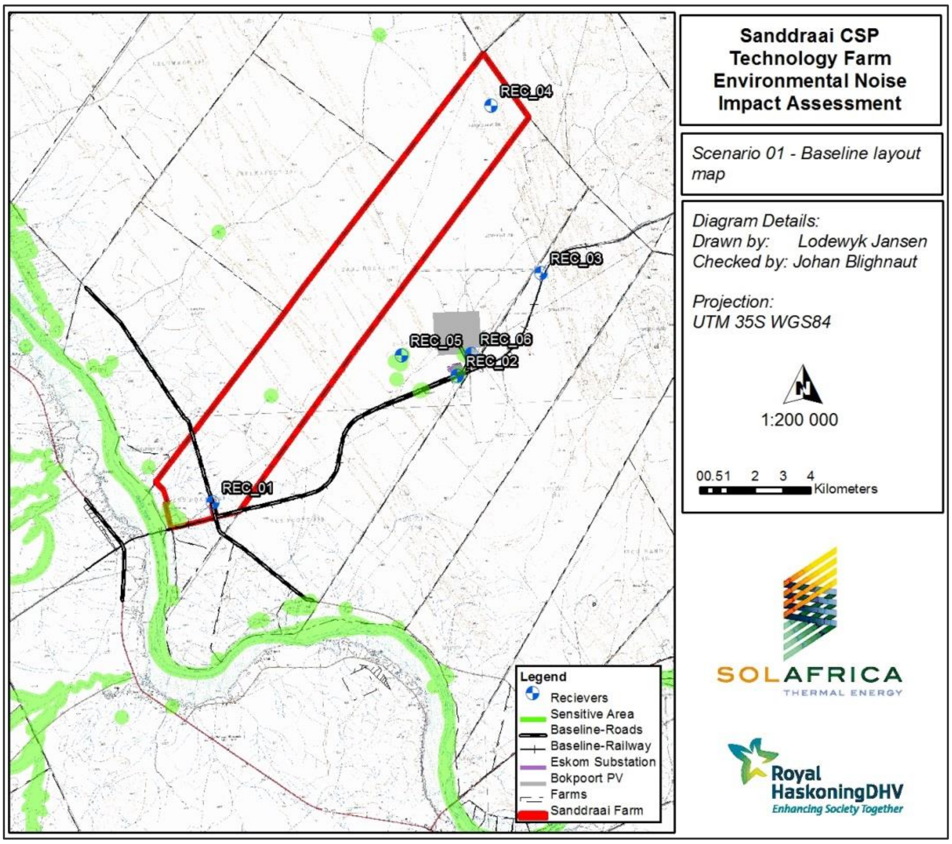

Figure 13: Scenario 01 – Illustration of sources relative to site boundary

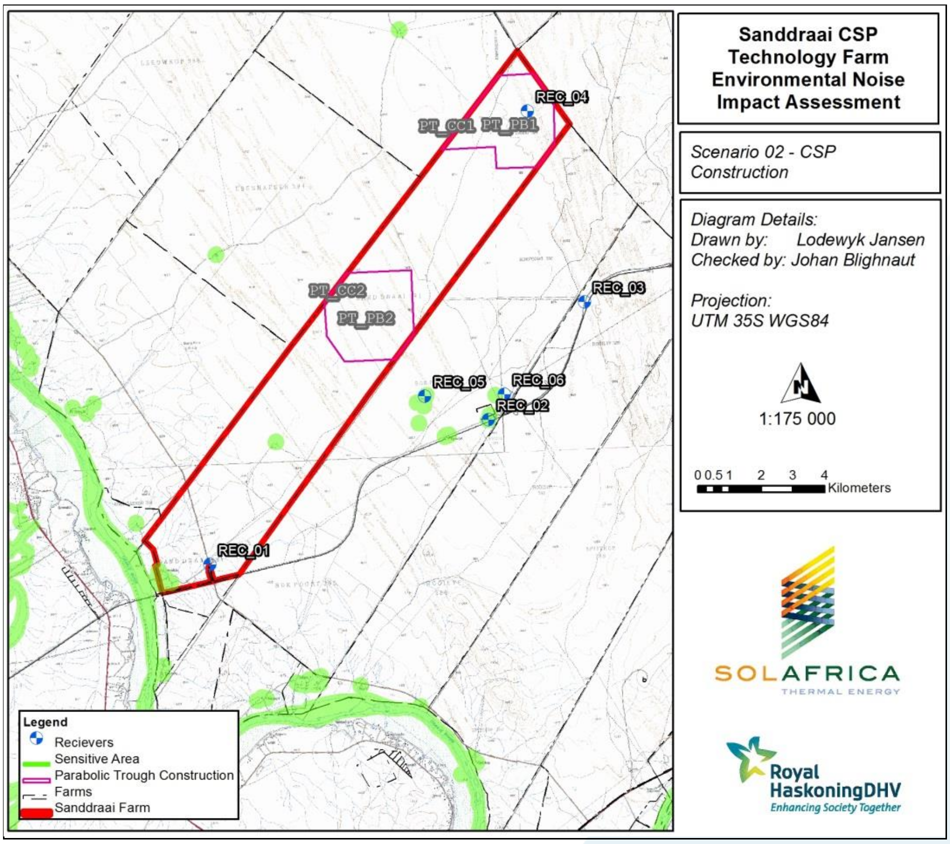

Figure 14: Scenario 02 – Illustration of sources relative to site boundary

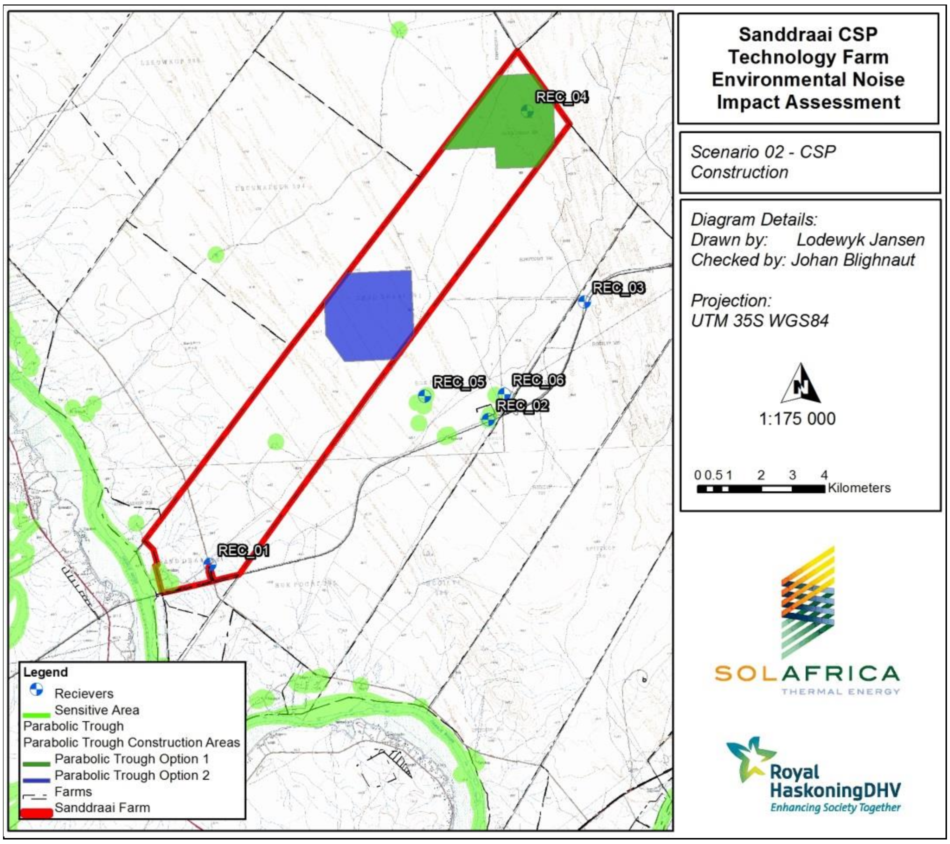

Figure 15: Scenario 03 – Illustration of sources relative to site boundary

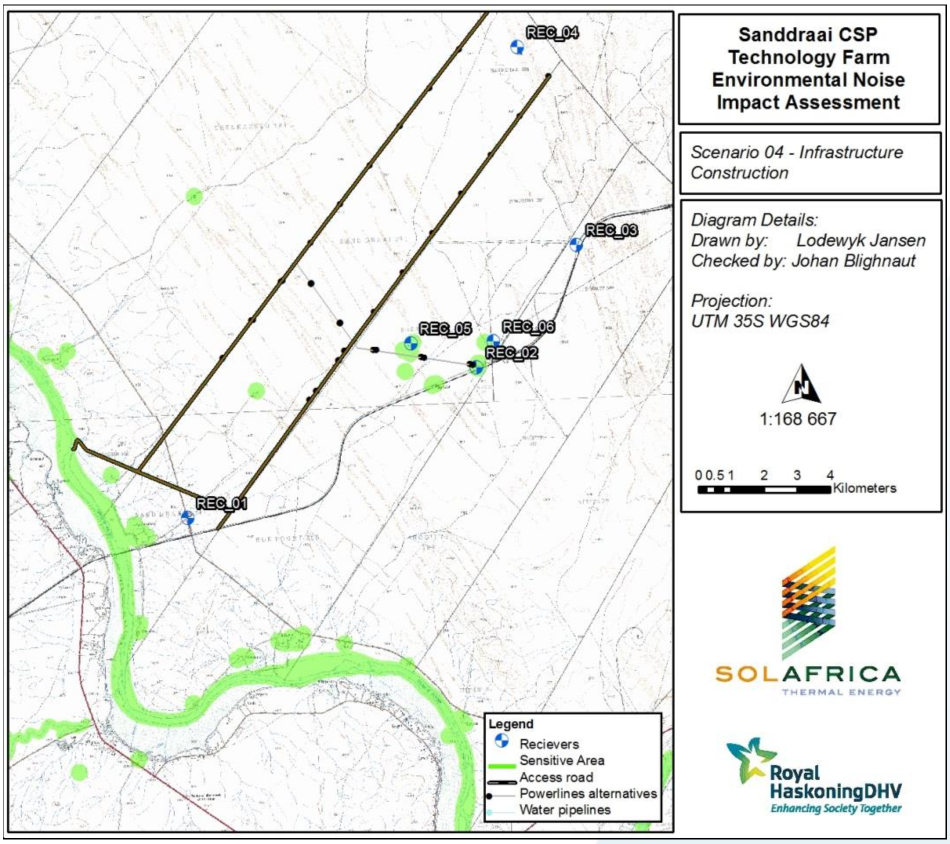

Figure 16: Scenario 04 – Illustration of sources relative to site boundary

7 Results

The following section present the results calculated at the sensitive receptors based on the corrected calculated baseline sound levels calculated in the baseline scenario (see Table 16). The noise level results calculated are based on the additional noise sources in the region and must be added to the baseline noise level to determine the cumulative noise level at each receiver. This noise level will be evaluated against the desired land use maximum allowable noise rating level and the increase in noise level will be indicated in the last columns.

Table 16: Baseline Noise Level Results

ID	Name	Model Calculated Baseline (dBA)			Corrected Baseline Noise Level (dBA)		
		$L_{Req,d}$	$L_{Req,n}$	$L_{Req,dn}$	$L_{Req,d}$	$L_{Req,n}$	$L_{Req,dn}$
REC_01	Sand Draai farm gate	44.8	34.8	44.8	45.2	35.1	45.2
REC_02	Eskom substation	47.1	47.7	53.6	47.3	47.7	53.7
REC_03	Loop16 North	27.6	0.0	25.8	35.0	23.4	34.5
REC_04	Sand Draai North	0.0	0.0	0.0	34.1	23.4	33.9
REC_05	Bokpoort farmhouse	23.3	11.9	22.9	34.4	23.7	34.2
REC_06	Bokpoort contractors offices	47.2	31.0	45.9	47.4	31.7	46.2

The corrected baseline value per receiver is calculated to include the unaccounted birdlife, wind, etc. noises which is not possible to model. The corrected baseline noise level improves the accuracy of the model and the results per scenario.

Based on the results following it was found that no additional mitigation modelling was required as none of the sensitive receptors were impacted. It should be noted, that even though the impact is minimal, the best available technologies (sound proofing) and practices should be implemented and become a culture at the site to ensure the noise generated onsite and off-site is as low as possible.

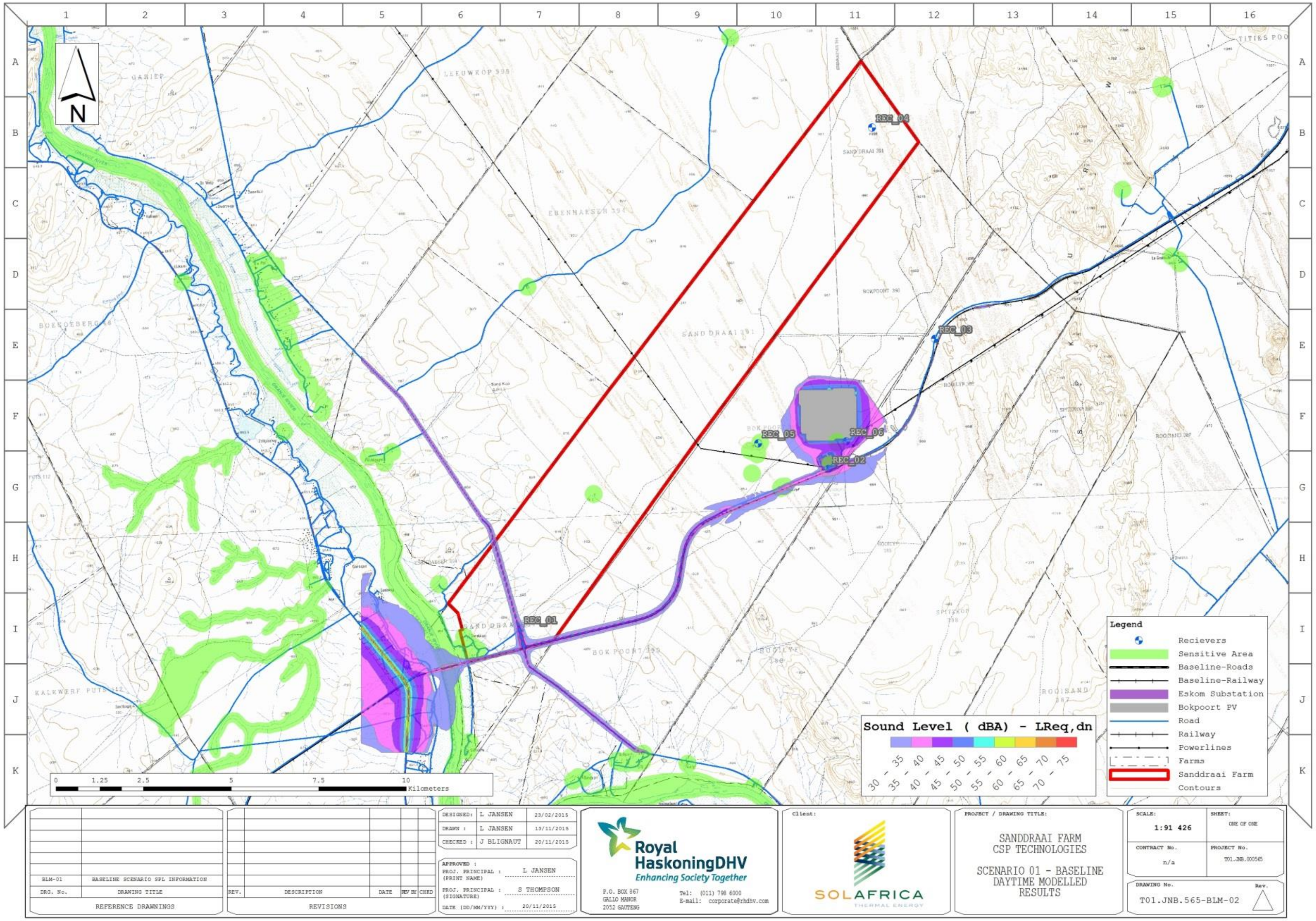

Figure 17: Baseline Modelled Result (iso-decibel lines) – $L_{Req,dn}$

7.1 Scenario 02 – Construction Phase

In the table below are the results of the modelled construction activities that are expected during the construction of the facility. The noise generated by the activities does not extent to the allocated receivers for this project (column Modelled Scenario Results), concluding that the area is unlikely to be impacted by the construction activities. It should be noted that REC_04 is located on top of the area source and should be excluded from the analysis of the impact for the scenario.

Table 17: Scenario 02 – Sensitive Receptor Results Summary

CODE ID	Baseline Noise Level (calculated)			Modelled Scenario Results			Cumulative Noise Levels *(Baseline + Modelled Results)*			Difference in noise level based on baseline scenario		
	Day	Night	Day/Night	Day	Night	Day/Night	Day	Night	Day/Night	Day	Night	Day/Night
	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA
REC_01	45.2	35.1	45.2	0.00	0.00	0.00	45.20	35.10	45.17	n.r.	n.r.	n.r.
REC_02	47.3	47.7	53.7	0.00	0.00	0.00	47.30	47.70	53.66	n.r.	n.r.	n.r.
REC_03	35.0	23.4	34.5	0.00	0.00	0.00	35.00	23.40	34.53	n.r.	n.r.	n.r.
REC_04	34.1	23.4	33.9	50.80	0.00	49.00	50.89	23.40	49.13	**16.79**	n.r.	**15.25**
REC_05	34.4	23.7	34.2	24.00	0.00	22.20	34.78	23.70	34.45	**0.38**	n.r.	**0.27**
REC_06	47.4	31.7	46.2	0.00	0.00	0.00	47.40	31.70	46.19	n.r.	n.r.	n.r.

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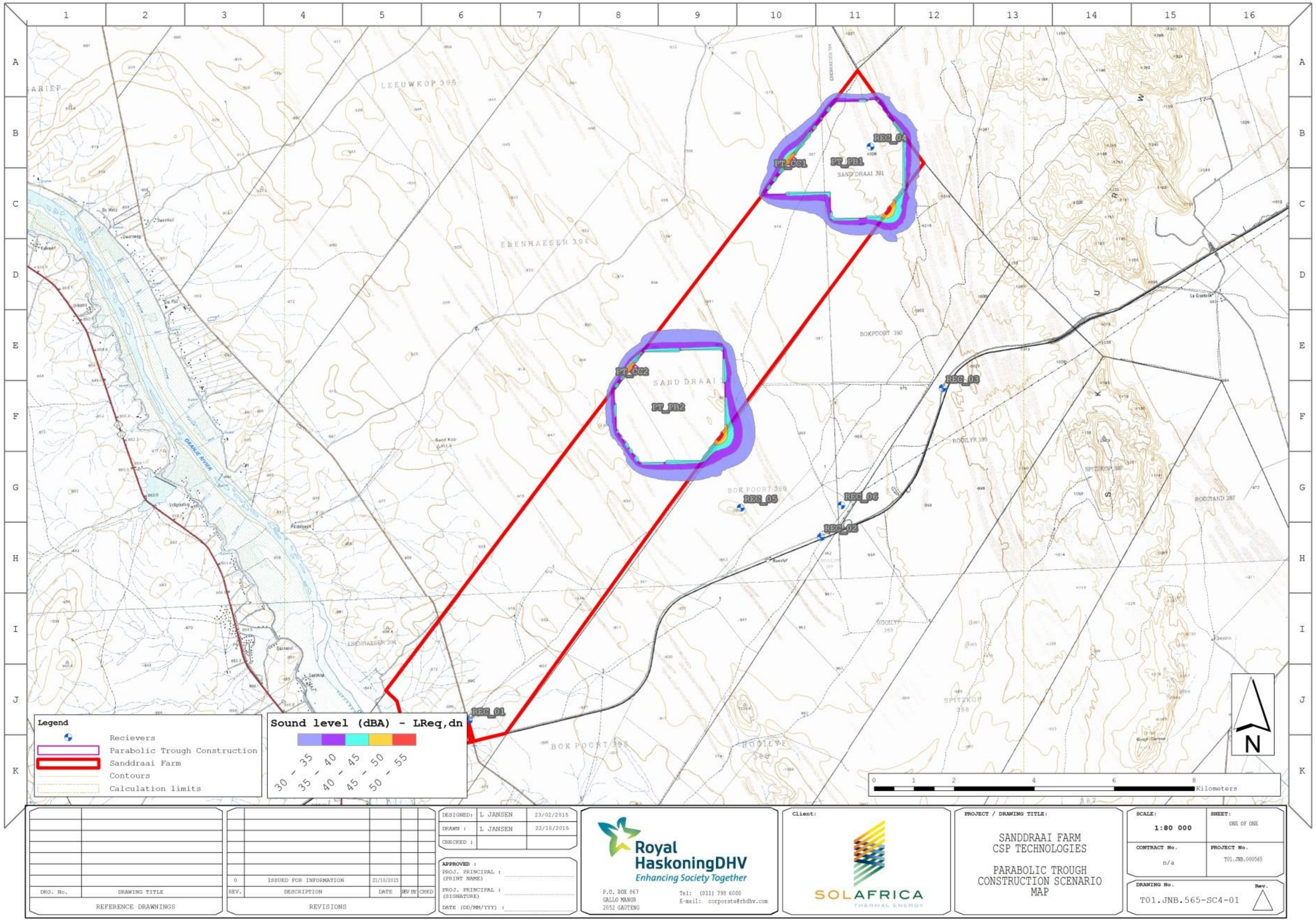

Figure 18: Scenario 02 Modelled results (iso-decibel lines) – $L_{Req,dn}$

7.2 Scenario 03 – Operational Phase

In the table below are the results of the modelled operational activities that are expected during the lifetime of the facility. The noise generated by the activities does extent to the allocated receivers for this project (column Modelled Scenario Results). The amount of sound received by the different receivers, range from 0.00 dBA to 23.00 dBA, which is low, due to the distance from source. The largest increase in the future expected sound level is +0.95 dBA during the night.

Table 18: Scenario 03 – Sensitive Receptor Results Summary

CODE ID	Baseline Noise Level (calculated)			Modelled Scenario Results			Cumulative Noise Levels *(Baseline + Modelled Results)*			Difference in noise level based on baseline scenario		
	Day	Night	Day/Night	Day	Night	Day/Night	Day	Night	Day/Night	Day	Night	Day/Night
	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA
REC_01	45.2	35.1	45.2	0.00	0.00	0.00	45.20	45.20	45.20	n.r.	n.r.	n.r.
REC_02	47.3	47.7	53.7	0.00	0.00	0.00	45.20	45.20	45.20	n.r.	n.r.	n.r.
REC_03	35.0	23.4	34.5	0.00	0.00	0.00	45.20	45.20	45.20	n.r.	n.r.	n.r.
REC_04	34.1	23.4	33.9	51.50	51.50	51.50	51.58	51.51	51.57	**17.48**	**28.11**	**17.69**
REC_05	34.4	23.7	34.2	22.90	22.90	22.90	34.70	26.33	34.49	**0.30**	**2.63**	**0.31**
REC_06	47.4	31.7	46.2	0.00	0.00	0.00	45.20	45.20	45.20	n.r.	n.r.	n.r.

7.3 Scenario 04 – Infrastructure Construction

The construction scenario of the different infrastructures is based on the information within the Sound Power Level Inventory, both options for the project was modelled together. Only the construction phase scenario will be investigated, as the operational phase of infrastructure are include in scenario 03.

Table 19: Scenario 04 - Sensitive Receptor Results Summary

CODE ID	Baseline Noise Level (calculated)			Modelled Scenario Results			Cumulative Noise Levels *(Baseline + Modelled Results)*			Difference in noise level based on baseline scenario		
	Day	Night	Day/Night	Day	Night	Day/Night	Day	Night	Day/Night	Day	Night	Day/Night
	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA
REC_01	45.2	35.1	45.2	9.70	0.00	7.90	45.20	45.20	45.17	**+0.01**	n.r.	**+0.01**
REC_02	47.3	47.7	53.7	0.00	0.00	0.00	45.20	45.20	45.20	n.r.	n.r.	n.r.
REC_03	35.0	23.4	34.5	0.00	0.00	0.00	45.20	45.20	45.20	n.r.	n.r.	n.r.
REC_04	34.1	23.4	33.9	25.60	0.00	23.80	34.67	45.20	34.29	**+0.57**	n.r.	**+0.41**
REC_05	34.4	23.7	34.2	28.10	0.00	26.40	35.31	45.20	34.85	**+0.91**	n.r.	**+0.67**
REC_06	47.4	31.7	46.2	0.00	0.00	0.00	45.20	45.20	45.20	n.r.	n.r.	n.r.

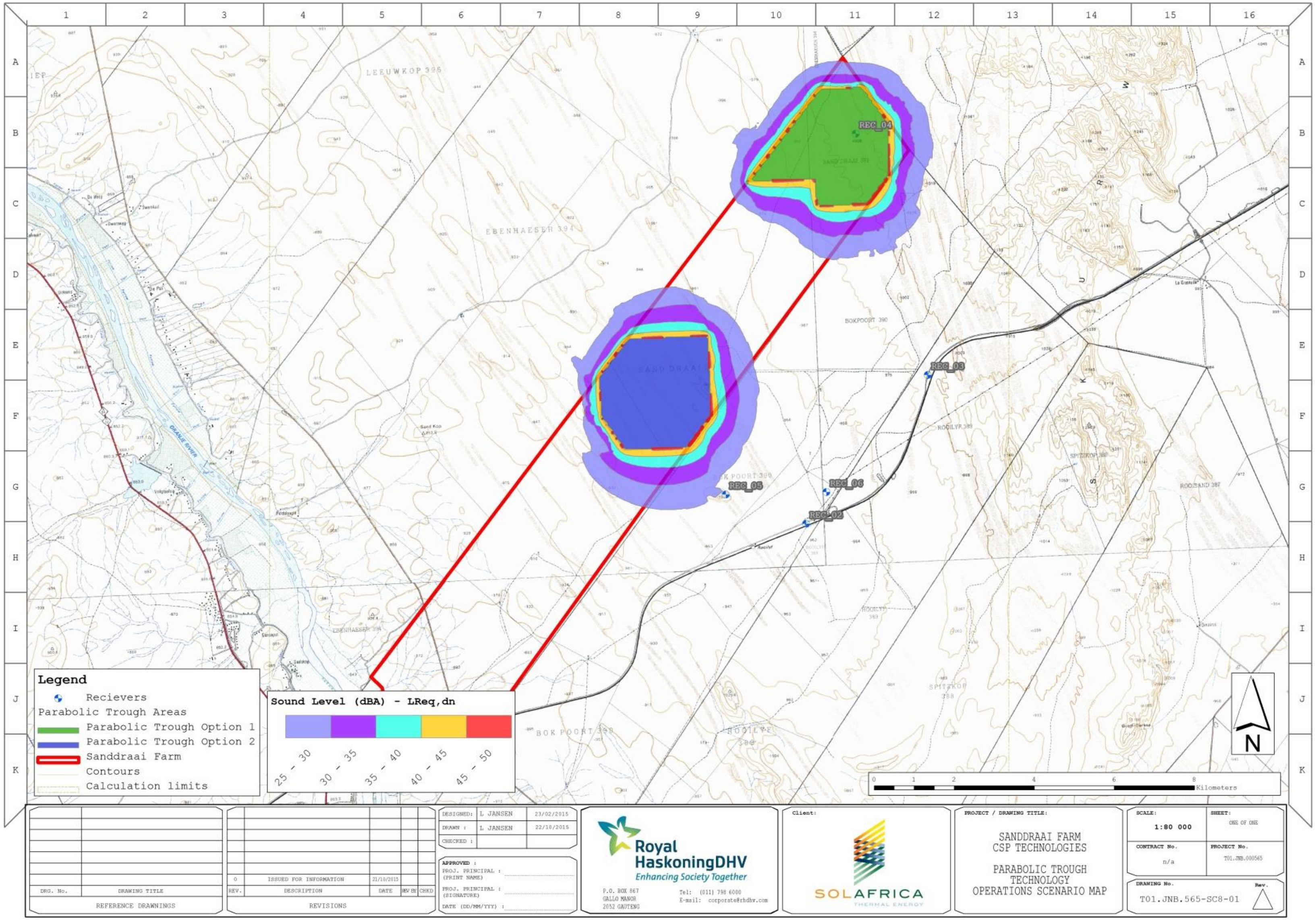

Figure 19: Scenario 03 Modelled results (iso-decibel lines) – $L_{Req,dn}$

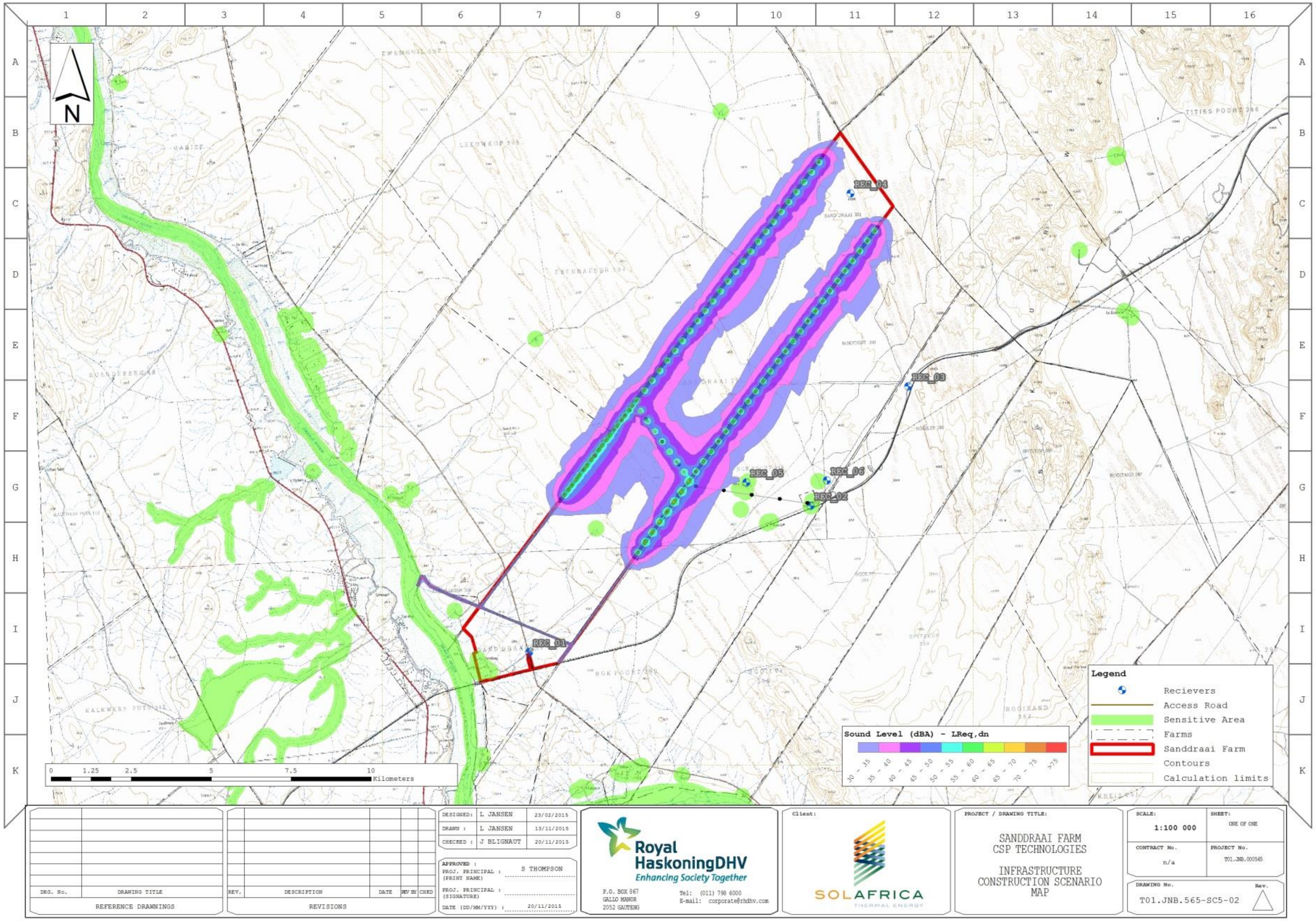

Figure 20: Scenario 04 Modelled results (iso-decibel lines) – $L_{Req,dn}$

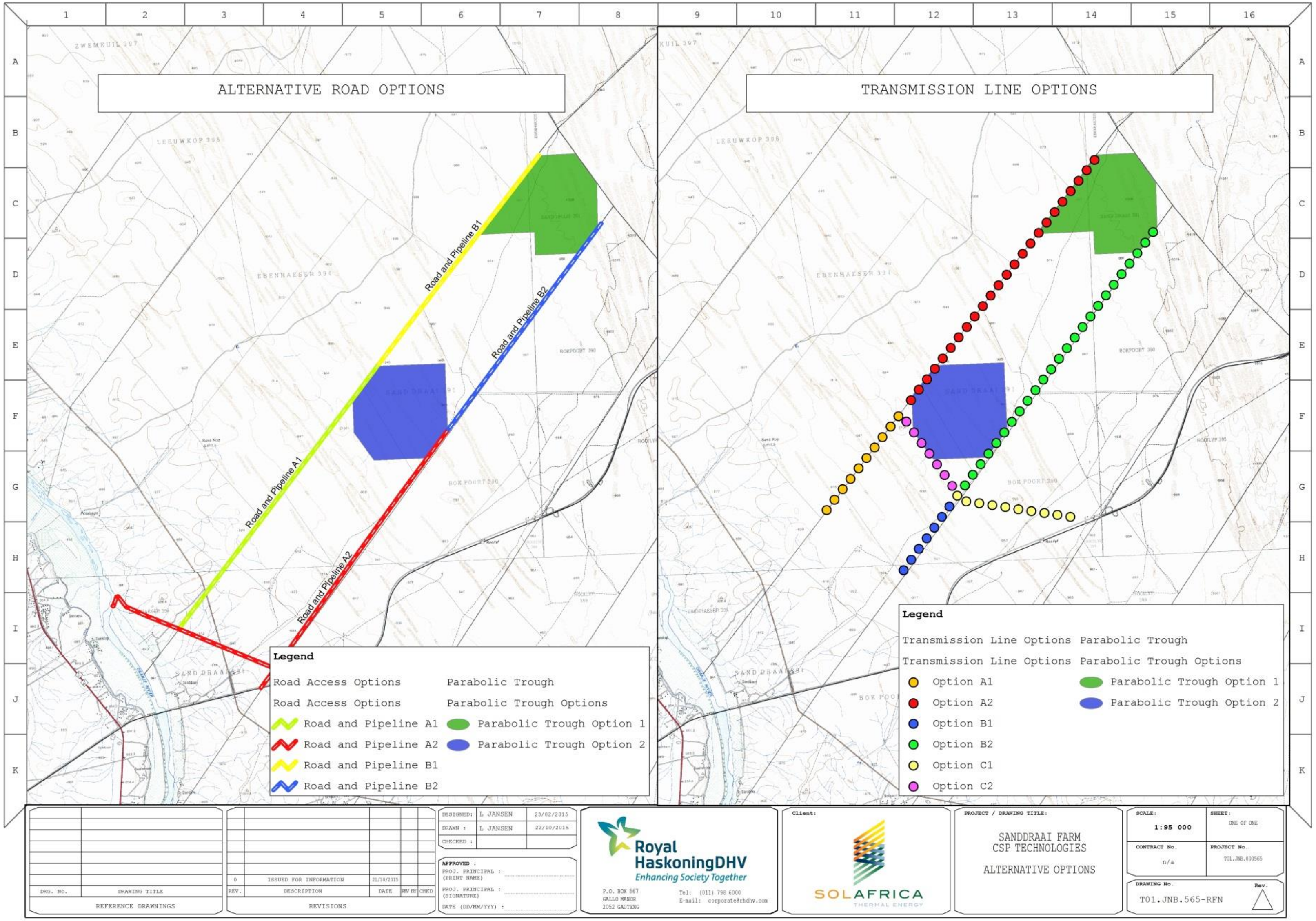

Figure 21: Map illustrating the different alternative options

8 Environmental Risk Rating

As mentioned earlier in the report the project consists of two alternative options for the siting of the Parabolic Trough Technology, thus only one of the alternative locations for the plant, road, water line and power lines will be chosen based on the impact the two alternatives has on the environment. See figure 21 above for the illustration of the different options available.

Although both alternatives locations were modelled together (layout of parabolic trough, access roads and transmission lines), it is possible to distinguish between the two alternative locations.

The northern sections of the farm (from the existing transmission line) are viewed as the first alternative, with all the remaining between the existing gravel road and transmission line, being alternative two. The infrastructures follow the same layout, but are also divided into option A and B. Option A being the most western option and Option B being the most eastern option (Please refer to Figure 21).

8.1 Sensitivity Assessment

This section will investigate and rate the different alternatives by their impact on the surrounding environment. The alternative most favourable will be assessed and specified in the title of the ratings table.

8.1.1 Construction of the CSP Plant using Parabolic Trough Technology

The construction phase included all construction activities. All construction workers were assumed to stay off-site and commute to the site daily. The typical noise that would be generated by the construction activities are all from heavy machinery and impact noises from incidents (such as falling pipes, equipment, etc.) – it should be noted that blasting activities are excluded from this investigation. The work hours of the construction phase will be limited to daylight hours. The loudest hour will be in the morning, once all the workers report at the site and the machinery is started up before work commences. The same is likely to occur, when the work day stops and all mobile equipment and machinery return to the construction camp.

During the hours of the working day, the noise is difficult to accurately determine due to the unpredictability and mobility of the noise sources onsite. The modelled results attempted to determine the noise generated from the power block construction and installation.

The extent of the noise impact (increasing the baseline noise level) is unlikely to occur at any of the receivers used in the modelling calculations. The same is the situation for the intensity (propagation of sound) from the source over the area.

If an impact occurred on site – the duration of such an event ranges from instantaneous to no more than a minute (very low duration). Such an impact (falling equipment, explosions, etc.) is very unlikely to occur and is unlikely to occur frequently.

Table 20: Environmental Risk Rating – Construction Phase of the CSP Plant using Parabolic Trough Technology (Parabolic Trough Option 2)

	Extent	Intensity	Duration	Probability	Frequency	Cumulative
Construction	1	1	1	1	1	5 (LOW)
Mitigated	1	1	1	1	1	5 (LOW)

8.1.2 Construction of associated infrastructure

Similar to the power plant development all workers will commute between the site and the nearby town each day. The noise will not all happen at once along the proposed areas, but will pass along the areas through the phase's lifetime. All construction will be limited to daylight hours. As the area of construction consists out of a varying list of equipment and unknown times and location of activity it is difficult to accurately determine the noise generated along the construction area. The best possible attempt was made and the calculated results are presented in Table 19. The loudest infrastructure noise source is the pile driving for the construction of the different pylons for the power line. Although the map indicate that construction at all the pylons "occurs simultaneously" the probability of simultaneous construction to occur is highly unlikely. The map is the worst case representation and can be used to determine the total area propagation once all construction is complete.

The extent of the noise impact (increasing the baseline noise level) is unlikely to occur at any of the receivers used in the modelling calculations. The same is the situation for the intensity (propagation of sound) from the source over the area.

If an impact occurred on site – the duration of such an event ranges from instantaneous to no more than a minute (very low duration). Such an impact (falling equipment, explosions, etc.) is very unlikely to occur and is unlikely to occur frequently.

Table 21: Environmental Risk Rating – Construction of the infrastructures for the CSP Plant using Parabolic Trough Technology (Access Road Option A; Transmission Line Option C2+C1)

	Extent	Intensity	Duration	Probability	Frequency	Cumulative
Construction	1	1	1	1	1	5 (LOW)
Mitigated	1	1	1	1	1	5 (LOW)

8.1.3 Operational Phase

The operational phase of the project will commence after the successful installation and testing of the technology. Similar to the construction phase, all workers will be based off site and the workers will commute to the site everyday. It is advisable that the access road from the town to the site be paved to ensure the impact is mitigated. At this moment in time the exact technology and power generation model is unknown – thus no in depth investigation could be made on low frequency noise. The calculations are based on accurate locations and sound power levels.

The extent of the noise impact (increasing the baseline noise level) is unlikely to occur at any of the receivers used in the modelling calculations. The same is the situation for the intensity (propagation of sound) from the source over the area.

If an impact occurred on site – the duration of such an event ranges from instantaneous to no more than a minute (very low duration). Such an impact (falling equipment, explosions, etc.) is very unlikely to occur and is unlikely to occur frequently.

Table 22: Environmental Risk Rating – Operational Phase of the CSP Plant using Parabolic Trough Technology (Parabolic Trough Option 2)

	Extent	Intensity	Duration	Probability	Frequency	Cumulative
Construction	1	1	1	1	1	5 (LOW)
Mitigated	1	1	1	1	1	5 (LOW)

Based on the environmental ratings provided above the project is unlikely to have any significant impact on the environment based on the calculated results. It is suggested that the **Parabolic Trough Alternative Option 2 and Access Road Alternative Option A1 including Transmission lines Alternative Option C1+C2** be considered for development.

9 Conclusion

The reason for the alternative options mentioned in section 8 is the locality to existing infrastructure and to minimise unnecessary, avoidable, long access roads, water pipelines and shorted power lines. In stating that Parabolic Trough Alternative Option 2 is the preferred location, Parabolic Trough Alternative Option 1 is also acceptable, although the long access road could pose some nuisance to the local farming community in the region (on either option aka Option A1+B1 or A2+B2).

In review of the results calculated from the propagation model in the previous section, it indicates that the cumulative effects of the operations are minimal on the surrounding environment and the majority of noise will be localised to the source' boundary. This is in line with the findings of Tsoutsos *et al.* that "The noise from the generating plant of large scale schemes (solar parks) is unlikely to cause any disturbance to the public."

9.1 Recommendations

To control the noise from the solar park, the following key points are highlighted by Royal HaskoningDHV to be investigated and implemented:

- Control of noise – On site
  - Avoid unnecessary revving of engines and switch off equipment when not required (construction and operational phases);
  - Keep solar field access routes well maintained and avoid speeding;
  - Start up plant and vehicles sequentially rather than all together (including auxiliary heater operations) (construction and operations);
  - Fitment of additional or best available exhaust silencers or acoustic canopies on engines including auxiliary heater operations) (construction and operations);
  - Where possible, attempt to enclose noise sources, if the sources enclose has a noise directivity ensure the noise is directed away from any sensitive areas; and
  - Regular and effective maintenance by trained personnel is essential and will do much to reduce noise from plant and machinery.
- Controlling the propagation of noise
  - Minimise the length and magnitude of noise sources;
  - Screening of noise sources, if it is not possible to increase the distance, the alternative measure is to screen the noise source. Screening can make use of the natural environment, existing buildings and/or screens or earth berms. These screens should be placed in the direct line of sight to effectively reduce the noise received and the sensitive location.
- Noise control targets
  - Monitoring of noise at sites where noise is an issue should be regarded as essential. Measurements may be carried out for a number of reasons, including the following:

    To allow the performance of noise control measures to be assessed;

    To ascertain noise form items of plant for planning purposes;

    To provide confirmation that planning requirements have been complied with.
  - Monitoring positions should reflect the purpose for which monitoring is carried out.

10 References

SOUTH AFRICAN NATIONAL STANDARD - Code of practice, SANS 10103:2008, The measurement and rating of environ-mental noise with respect to land use, health, annoyance and to speech communication.

SOUTH AFRICAN STANDARD - Code of practice, SABS 10210:2004, Calculating and predicting road traffic noise.

SOUTH AFRICAN STANDARD - Code of practice, SABS 10328:2008, Methods for environmental nose impact assessments.

SOUTH AFRICAN STANDARD - Code of practice, SABS 10357: 2008, The calculation of sound propagation by the Concawe method.

DEPARTMENT OF ENVIRONMENTAL AFFAIRS. NO. R. 154. Noise Control Regulations in Terms of Section 25 of the Environmental Conservation Act, 1989 (Act No. 73 of 1989). Govt. Gazette. No. 13717, 10 January 1992.

Tsoutsos, T., Frantzeskaki, N. & Gekas, V. (2005). Environmental impacts from the solar energy technologies. Elsriver, Energy Policy 33 (2005) 289-296

Appendix A

Environmental Noise Specialist Declaration and CV

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF SPECIALIST AND DECLARATION OF INTEREST

	(For official use only)
File Reference Number:	12/12/20/ or 12/9/11/L
NEAS Reference Number:	DEA/EIA
Date Received:	

Application for integrated environmental authorisation and waste management licence in terms of the-

(1) National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2014; and

(2) National Environmental Management Act: Waste Act, 2008 (Act No. 59 of 2008) and Government Notice 921, 2013

PROJECT TITLE

EIA for the proposed Solafrica Sand Draai Parabolic Trough Project, within the ! Kheis Local Municipality, Northern Cape

Specialist:	**Environmental Noise**		
Contact person:	**Lodewyk Jansen**		
Postal address:	**PO Box 867, Gallo Manor**		
Postal code:	**2052**	Cell:	
Telephone:	**011 978 6570**	Fax:	
E-mail:	**Lodewyk.jansen@rhdhv.co**		
Professional affiliation(s) (if any)	**SACNASP Pri.Sci.Nat (400691/15)** **Acoustical Society of America (1234254)**		

Project Consultant:	**Royal HaskoningDHV**		
Contact person:	**Malcolm Roods**		
Postal address:	**PO Box 867, Gallo Manor**		
Postal code:	**2052**	Cell:	
Telephone:	**0117986000**	Fax:	**0117986010**
E-mail:	**Malcolm.roods@rhdhv.com**		

4.2 The specialist appointed in terms of the Regulations_

I, Lodewyk Jansen , declare that --

General declaration:

I act as the independent specialist in this application;

I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;

I declare that there are no circumstances that may compromise my objectivity in performing such work;

I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;

I will comply with the Act, Regulations and all other applicable legislation;

I have no, and will not engage in, conflicting interests in the undertaking of the activity;

I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;

all the particulars furnished by me in this form are true and correct; and

I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the specialist:

Royal HaskoningDHV

Name of company (if applicable):

2015/11/12

Date:

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Appendix B

Sound Power Level Inventory & Calculations

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Appendix C

Environmental Noise Specilalist Cartography

Iso-decibel propagation results

**All published maps can be made available in high definition upon request thereof.*

With its headquarters in Amersfoort, The Netherlands, Royal HaskoningDHV is an independent, international project management, engineering and consultancy service provider. Ranking globally in the top 10 of independently owned, nonlisted companies and top 40 overall, the Company's 6,500 staff provide services across the world from more than 100 offices in over 35 countries.

Our connections

Innovation is a collaborative process, which is why Royal HaskoningDHV works in association with clients, project partners, universities, government agencies, NGOs and many other organisations to develop and introduce new ways of living and working to enhance society together, now and in the future.

Memberships

Royal HaskoningDHV is a member of the recognised engineering and environmental bodies in those countries where it has a permanent office base.

All Royal HaskoningDHV consultants, architects and engineers are members of their individual branch organisations in their various countries.

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