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François Malherbe Acoustic Consulting cc

**REPORT**

# Central Térmica de Temane Project - Noise Impact Assessment

*Moz Power Invest, S.A. and Sasol New Energy Holdings (Pty) Ltd*

Submitted to:

**Ministry of Land, Environment and Rural Development (MITADER)**

Submitted by:


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# Executive Summary

This report describes the purpose, methodology, results and findings of a noise study on the planned Central Térmica de Temane (CTT) project. Two technologies are being considered, i.e. an Open Cycle Gas Engine (OCGE) plant and a Closed Cycle Gas Turbine (CCGT) plant.

The pre-development ambient noise levels have been the subject of detailed past studies and it was decided that new noise measurements in the field were not required. Therefore, for the purpose of the current noise study it was assumed that the results of the previous studies still apply. The impact of the noise emissions from the planned CTT plant was modelled and assessed on the basis of the previously established ambient noise levels.

A three-dimensional model of the noise emissions during day- and night-time from the planned CTT plant was developed for both technology options. The impacts of these noise emissions were expressed as the total of the increase in ambient noise levels in the environment as a result of the CTT plant. The results are presented in terms of noise contours projected on a georeferenced satellite image.

The analysis shows that:

- For both technologies the significance of the noise impacts during construction are negligible, low under operational conditions and negligible during decommissioning;
- [Include a bullet to say what are the resulting noise levels and how they compare to the WHO/IFC requirements]
- For residential areas the WHO/IFC requirements stipulate a time averaged outdoor noise level of 55 dBA and 45 dBA over the day- (typically 16 hours) and night-time (typically 8 hours) periods, respectively. The calculation results show that the contours describing these recommended noise levels fall in close proximity to the developments during construction, operation and decommissioning. No households will fall within these contours;
- The IFC adds a further requirement to those described in the previous bullet in that the noise emissions from a development should not increase the existing ambient noise levels by more than 3 dB. The calculation results show that the OCGE option meets this requirement during the day-time. Although during night time, this threshold is exceeded and the 3 dB contour will cover a significantly larger area, including four households;
- The maximum noise impacts occur during the night-time period, due to ambient noise levels being lower than during day-time plus the fact that meteorological and other atmospheric conditions favour the propagation of sound at night; and
- The OCGE technology produces the larger noise impact footprint.

The noise impact is largely determined by the noise emissions from the cooling fans. Therefore, if mitigation measures are to be considered, the noise emissions from these fans will be reduced. In view of the absence of further technical details it was not meaningful to further investigate the application of any noise control measures on the cooling fans.

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# ACRONYMS

| Acronym | Description |
|---|---|
| Δ | Greek symbol for the difference between two quantities of the same unit |
| CCGT | Closed Cycle Gas Turbine |
| CONCAWE | Conservation of Clean Air and Water in Europe |
| CTT | Central Térmica de Temane |
| dB | Deci Bel |
| dBA | Deci Bel A-weighted |
| IFC | International Finance Corporation |
| MW | Mega Watt |
| OCGE | Open Cycle Gas Engine |
| SANS | South African National Standard |
| WB | World Bank |
| WHO | World Health Organisation |

# 1.0 INTRODUCTION

The Mozambican economy is one of the fastest growing economies on the African continent with electricity demand increasing by approximately 6-8% annually. In order to address the growing electricity demand faced by Mozambique and to improve power quality, grid stability and flexibility in the system, Moz Power Invest, S.A. (MPI), a company to be incorporated under the laws of Mozambique and Sasol New Energy Holdings (Pty) Ltd (SNE) in a joint development agreement is proposing the construction and operation of a gas to power facility, known as the Central Térmica de Temane (CTT) project. MPI's shareholding will be comprised of EDM and Temane Energy Consortium (Pty) Ltd (TEC). The joint development partners of MPI and SNE will hereafter be referred to as the Proponent. The Proponent propose to develop the CTT, a 450MW natural gas fired power plant.

The proposed CTT project will draw gas from either the Sasol Exploration and Production International (SEPI) gas well field via the phase 1 development of the PSA License area, covering gas deposits in the Temane and Pande well fields in the Inhassoro District and the existing Central Processing Facility (CPF) or from an alternative gas source. Consequently, the CTT site is in close proximity to the CPF. The preferred location for the CTT is approximately 500 m south of the CPF. The CPF, and the proposed site of the CTT project, is located in the Temane/Mangugumete area, Inhassoro District, Inhambane Province, Mozambique; and approximately 40 km northwest of the town of Vilanculos. The Govuro River lies 8 km east of the proposed CTT site. The estimated footprint of the CTT power plant is approximately 20 ha (see Figure 1).

Associated infrastructure and facilities for the CTT project will include:

1) Electricity transmission line (400 kV) and servitude; from the proposed power plant to the proposed Vilanculos substation over a total length of 25 km running generally south to a future Vilanculos substation. [Note: the development of the substation falls outside the battery limits of the project scope as it is part of independent infrastructure authorised separately (although separately authorised, the transmission line will be covered by the Project ESMP, and the Vilanculos substation is covered under the Temane Transmission Project (TTP) Environmental and Social Management Plans). Environmental authorisation for this substation was obtained under the STE/CESUL project. (MICOA Ref: 75/MICOA/12 of 22nd May)];

2) Piped water from one or more borehole(s) located either on site at the power plant or from a borehole located on the eastern bank of the Govuro River (this option will require a water pipeline approximately 11km in length);

3) Access road; over a total length of 3 km, which will follow the proposed water pipeline to the northeast of the CTT to connect to the existing Temane CPF access road;

4) Gas pipeline and servitude; over a total length of 2 km, which will start from the CPF high pressure compressor and run south on the western side of the CPF to connect to the power plant or from an alternative gas source;

5) Additional nominal widening of the servitude for vehicle turning points at points to be identified along these linear servitudes;

6) A construction camp and contractor laydown areas will be established adjacent to the CTT power plant footprint; and

7) Transhipment and barging of equipment to a temporary beach landing site and associated logistics camp and laydown area for the purposes of safe handling and delivery of large oversized and heavy equipment and infrastructure to build the CTT. The transhipment consists of a vessel anchoring for only approximately 1-2 days with periods of up to 3-4 months between shipments over a maximum 15-month period early in

the construction phase, in order to offload heavy materials to a barge for beach landing. There are 3 beach landing site options, namely SETA, Maritima and Briza Mar (Figure 7). The SETA site is considered to be the preferred beach landing site for environmental and other reasons; it therefore shall be selected unless it is found to be not feasible for any reason;

8) Temporary bridges and access roads or upgrading and reinforcement of existing bridges and roads across sections of the Govuro River where existing bridges are not able to bear the weight of the equipment loads that need to be transported from the beach landing site to the CTT site. Some new sections of road may need to be developed where existing roads are inaccessible or inadequate to allow for the safe transport of equipment to the CTT site. The northern transport route via R241 and EN1 is considered as the preferred transport route (Figure 8) on terrestrial impacts; however, until the final anchor point is selected, and the barge route confirmed, the marine factors may still have an impact on which is deemed the overall preferable route.

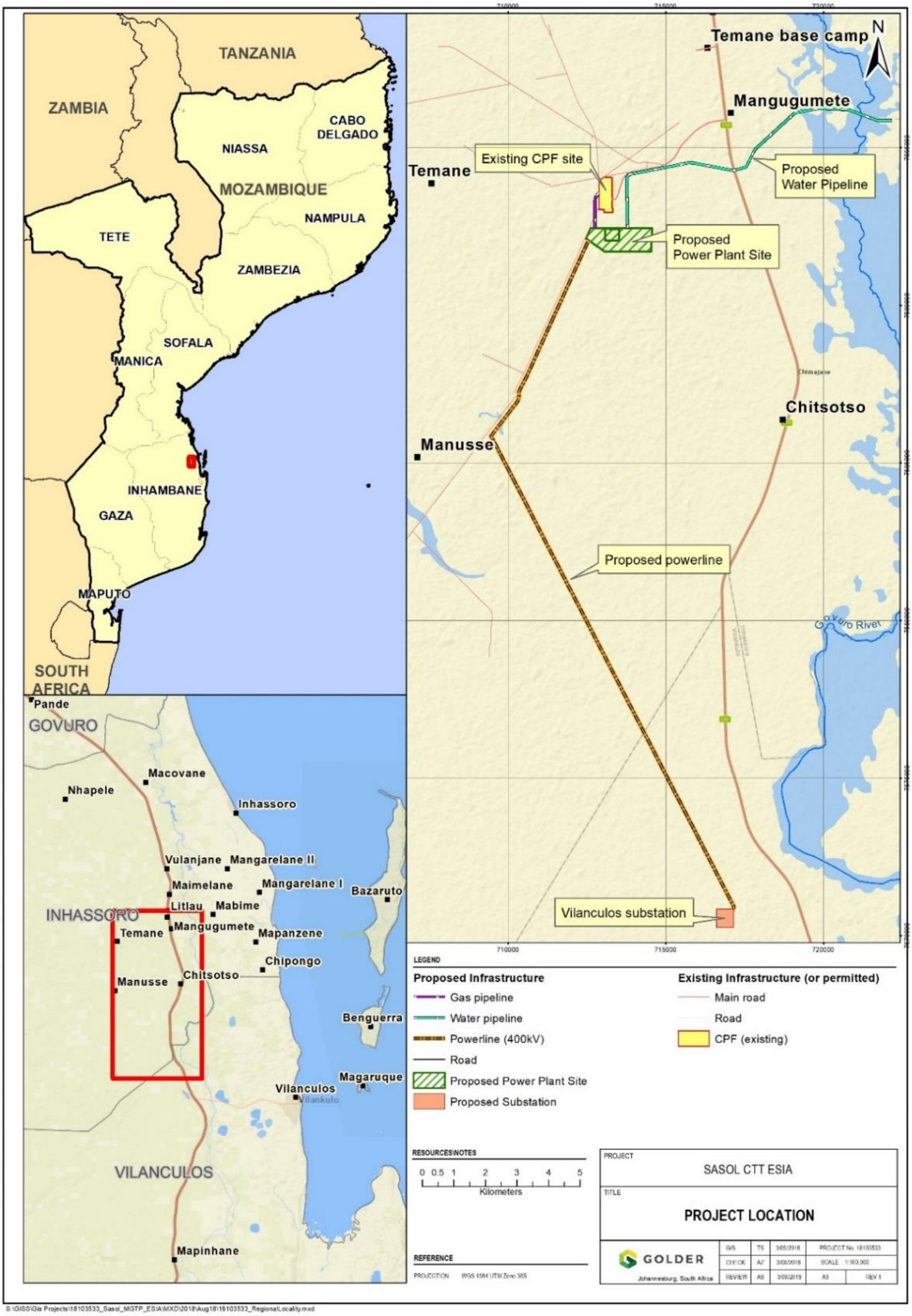


**Figure 1: Project Location**

## 2.0 DESCRIPTION OF THE KEY PROJECT COMPONENTS

The CTT project will produce electricity from natural gas in a power plant located 500m south of the CPF. The project will consist of the construction and operation of the following main components:

- Gas to Power Plant with generation capacity of 450MW;
- Gas pipeline (±2 km) that will feed the Power Plant with natural gas from the CPF or from an alternative gas source;
- 400kV Electrical transmission line (± 25 km) with a servitude that will include a fire break (vegetation control) and a maintenance road to the Vilanculos substation. The transmission line will have a partial protection zone (PPZ) of 100m width. The transmission line servitude will fall inside the PPZ;
- Water supply pipeline to a borehole located either on site or at borehole located east of the Govuro River;
- Surfaced access road to the CTT site and gravel maintenance roads within the transmission line and pipeline servitudes;
- Temporary beach landing structures at Inhassoro for the purposes of delivery of equipment and infrastructure to build the power plant. This will include transhipment and barging activities to bring equipment to the beach landing site for approximately 1-2 days with up to 3-4 months between shipments over a period of approximately 8-15 months;
- Construction camp and contractor laydown areas adjacent to the CTT power plant site; and
- Temporary bridge structures across Govuro River and tributaries, as well possible new roads and/or road upgrades to allow equipment to be safely transported to site during construction.


**Figure 2: Examples of gas to power plant sites (source: www.industcards.com and www.wartsila.com)**

The final selection of technology that will form part of the power generation component of the CTT project has not been determined at this stage. The two power generation technology options that are currently being evaluated are:

- Combined Cycle Gas Turbine (CCGT); and
- Open Cycle Gas Engines (OCGE).

Please refer to Chapter 4 of the main ESIA document for further details on the technology option.

At this early stage in the project a provisional layout of infrastructure footprints, including the proposed linear alignments is indicated in Figure 1. A conceptual layout of the CTT plant site is shown below in Figure 3.

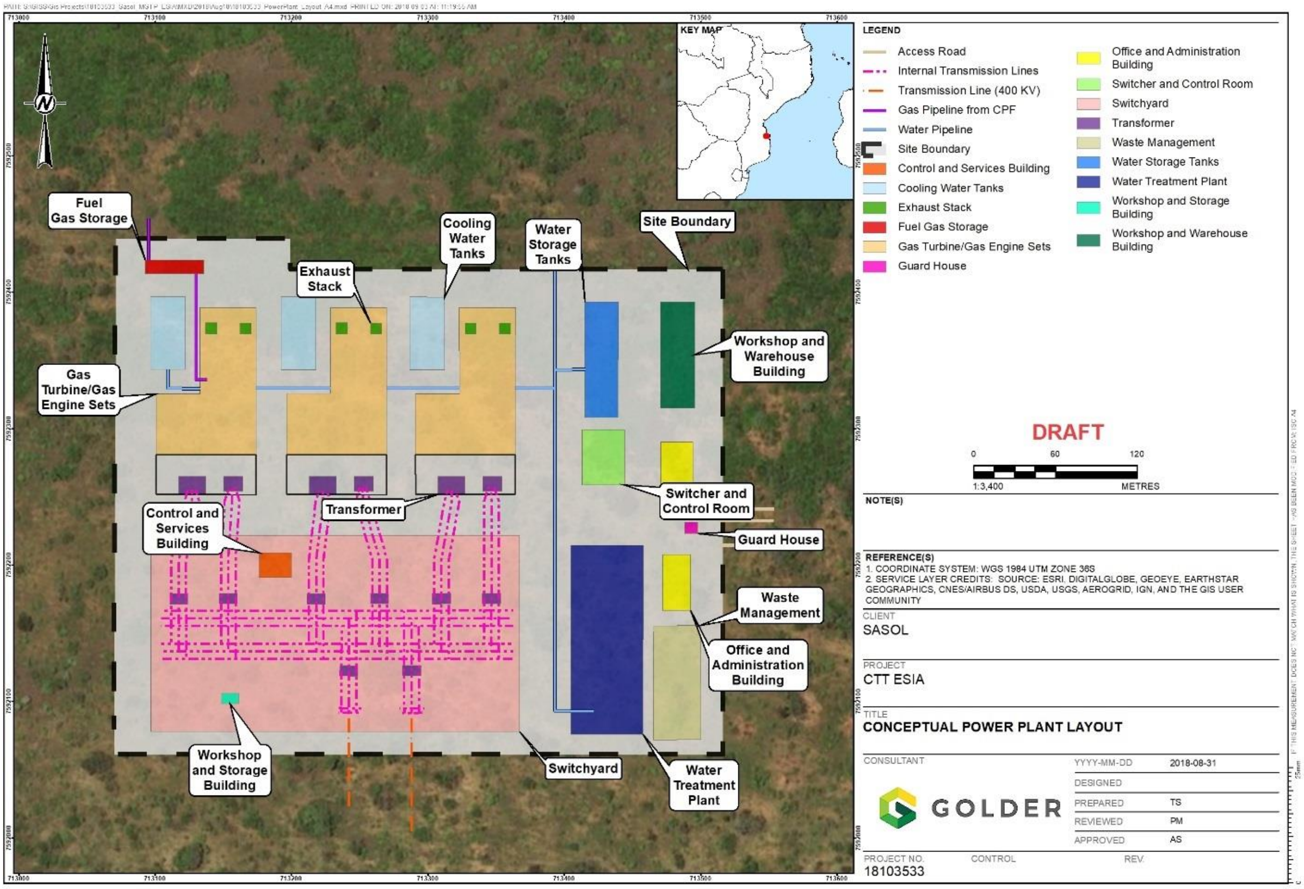


**Figure 3: Conceptual layout of CTT plant site**

## 2.1 Ancillary Infrastructure

The CTT project will also include the following infrastructure:

- Maintenance facilities, admin building and other buildings;
- Telecommunications and security;
- Waste (solid and effluent) treatment and/or handling and disposal by third party;
- Site preparation, civil works and infrastructure development for the complete plant;
- Construction camp (including housing/accommodation for construction workers); and
- Beach landing laydown area and logistics camp.

The heavy equipment and pre-fabricated components of the power plant will be brought in by ship and transferred by barge and landed on the beach near Inhassoro. The equipment and components will be brought to site by special heavy vehicles capable of handling abnormally heavy and large dimension loads. Figure 4, Figure 5 and Figure 6 show examples of the activities involved with a temporary beach landing site, offloading and transporting of large heavy equipment by road to site.

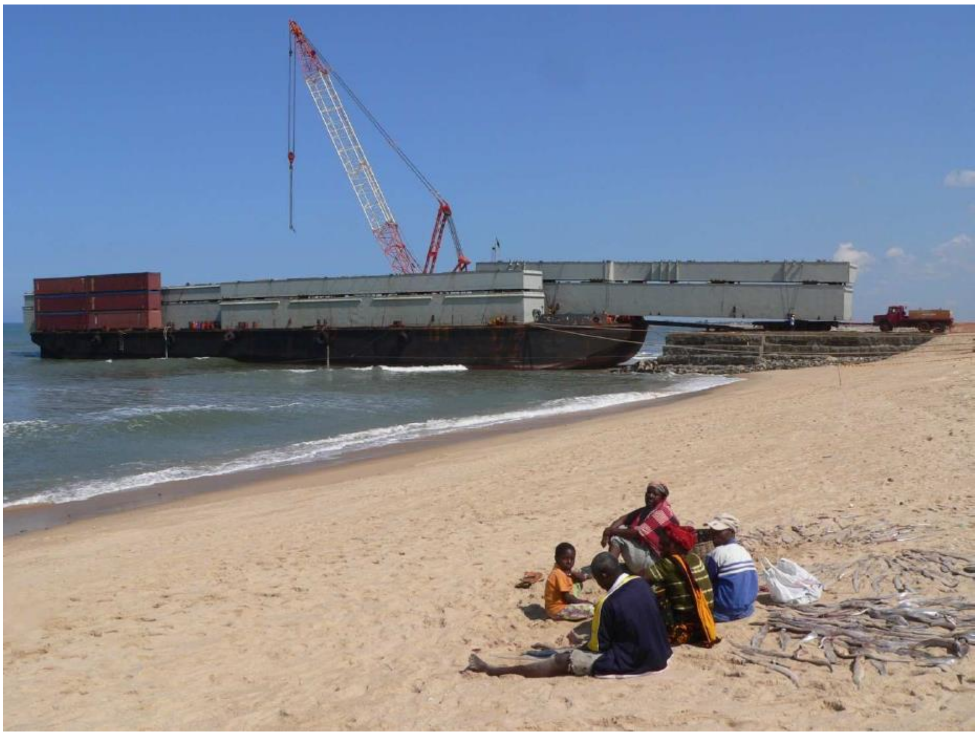

**Figure 4: Typical beach landing site with barge offloading heavy equipment (source: Comarco)**

**Figure 5: Example of large equipment being offloaded from a barge. Note the levels of the ramp, the barge and the jetty (source: SUBTECH)**

**Figure 6: Heavy haulage truck with 16-axle hydraulic trailer transporting a 360 ton generator (source: ALE)**

## 2.2 Water and electricity consumption

The type, origin and quantity of water and energy consumption are still to be determined based on the selected technology to construct and operate the CTT plant. At this stage it is known that water will be sourced from existing boreholes located on site or east of the Govuro River for either of the technology options below:

- Gas Engine: ± 12 $m^3$/day; or
- Gas Turbine (Dry-Cooling): ± 120 – 240 $m^3$/day.

## 2.3 Temporary Beach Landing Site and Transportation Route Alternative

As part of the CTT construction phase it was considered that large heavy equipment and materials would need to be brought in by a ship which would remain anchored at sea off the coast of Inhassoro. Equipment and materials would be transferred to a barge capable of moving on the high tide into very shallow water adjacent to the beach to discharge its cargo onto a temporary off-loading jetty (typically containers filled with sand) near the town of Inhassoro. As the tide changes, the barge rests on the beach and off-loading of the equipment commences.

Currently, the SETA beach landing site is the preferred beach landing site together with the road route option to be used in transporting equipment and materials along the R241 then the EN1 then via the existing CPF access road to the CTT site near the CPF. Figure 7 and Figure 8 indicate the beach landing site and route transportation option. The alternative beach landing sites of Maritima and Briza Mar are still being evaluated as potential options, as well as the southern transport route, which would also require road upgrades and a temporary bridge construction across the Govuro at the position of the existing pipe bridge. As part of the transportation route, the Govuro River bridge may need to be upgraded / strengthened to accommodate the abnormal vehicle loads. Alternatively, a temporary bypass bridge will be constructed adjacent to the existing bridge.


**Figure 7: The three beach landing site options and route options at Inhassoro**

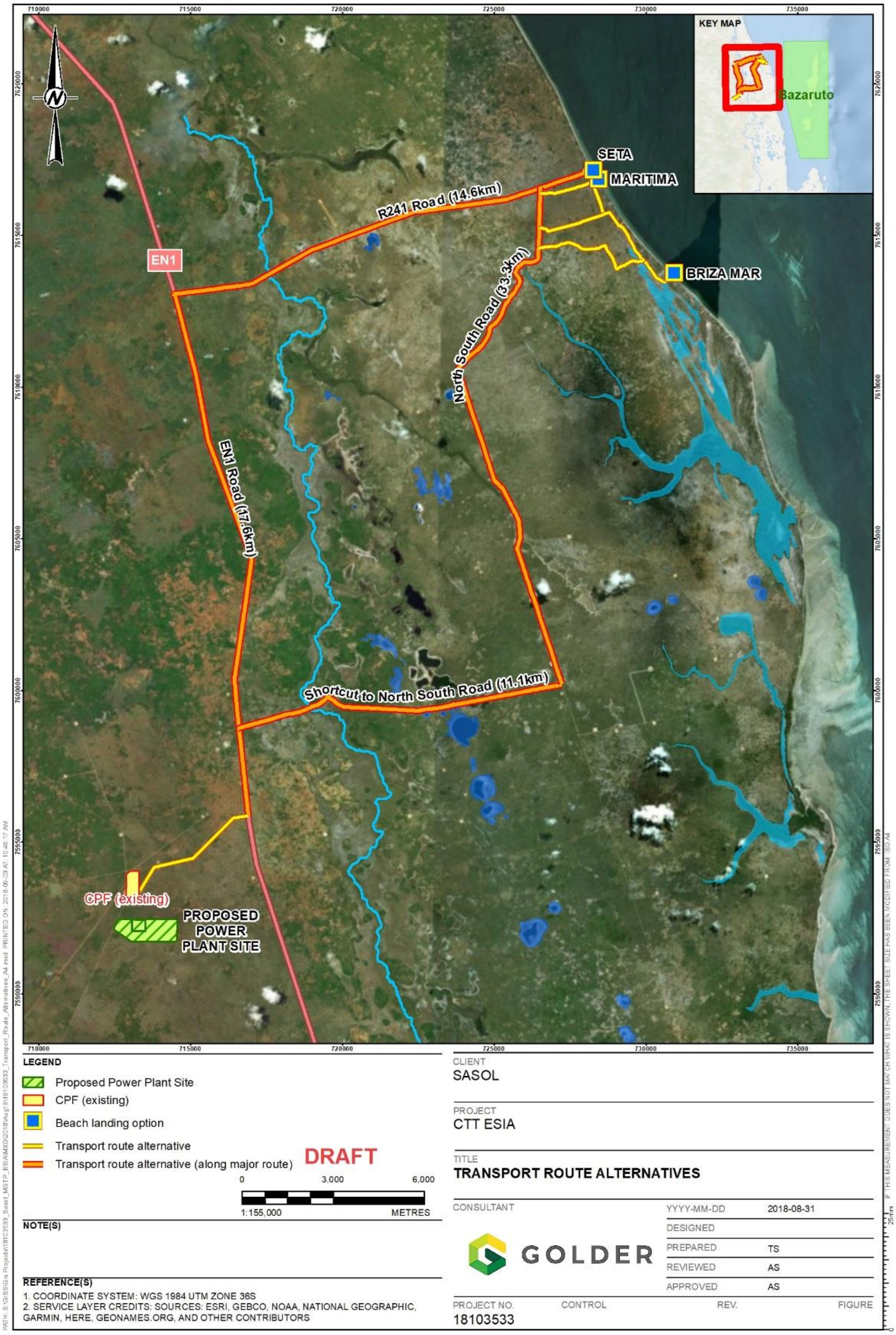


**Figure 8: The two main transportation route alternatives from the beach landing sites to the CTT site**

# 3.0 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

The proposed project has been determined as ‘Category A’ in terms of Mozambique’s environmental law (Decree 54/2015 of 31 December, which has been in force since April 2016). For ‘Category A’ projects, an Environmental and Social Impact Assessment (ESIA) must be prepared by independent consultants as a basis for whether or not environmental authorisation of the project is to be granted, and if so, under what conditions. The final decision maker is the Ministry of Land, Environment and Rural Development (Ministério da Terra, Ambiente e Desenvolvimento Rural (MITADER) through the National Directorate of Environmental Impact Assessment (DNAIA). MITADER consults with other relevant government departments prior to making a decision.

This document represents the Noise Impact Assessment undertaken to support the ESIA. The noise study is undertaken in terms of the Mozambique’s environmental law (Decree 54/2015 of 31 December, which has been in force since April 2016), the World Bank Group operational policies and general environmental health and safety guidelines, and International Finance Corporation Performance Standards. The Mozambique environmental law provides general guidelines for conducting environmental impact assessments but does not specifically address noise as a pollutant. Mozambique has not promulgated its own noise regulations and reference is usually made to other standards and guidelines in cases where noise impacts need to be assessed. In this report, the South African National Standard (SANS) 10103 and the guidelines provided by the World Health Organisation (WHO) are also used as applicable guidelines. The World Bank and many other financiers have adopted these guidelines and compliance requirements at the CPF are based on them.

The WHO guidelines recommend day- and night-time ambient noise levels of 55 dBA and 45 dBA, respectively, for residential areas. These levels have been adopted as standards for the purposes of Sasol’s Operational Environmental Management Plan (oEMP) for the CPF and are therefore a compliance requirement against which the CTT joint venture is measured.

# 4.0 BASELINE CONDITIONS

## 4.1 Scope of study

The objective of the noise study is to assess the impact of the project on existing ambient noise in communities around the CTT site as a result of the construction and operation of a gas to power plant. The original Terms of Reference issued in December 2014 specified the following tasks for the noise study:

- Develop noise emission inventory using measurements of existing plant noise sources at the CPF;
- Map population density within 3 km of the plant and within 1 km of linear infrastructure;
- Assemble baseline noise data (use existing measured data from past CPF noise monitoring and additional field measurements of nearest homesteads);
- Model existing noise environment and correlate with field measurements using international noise modelling software;
- Model future noise environment based on data concerning future sources associated with the gas to power plant;
- Assess impacts by comparing results with WHO guidelines for daytime and night-time sound levels (as included in the existing Sasol oEMP in the area); and
- Recommend any necessary mitigation.

This applies to the following aspects of the project:

- Beach landing site with laydown area;
- Potential bridge upgrade;
- Transportation route;
- Construction camp; and
- CTT site itself with access road from CPF.

## 4.2 Study methodology

### 4.2.1 Desktop review of available information

The ambient noise levels in the environment of the existing CPF and the noise emission levels of key equipment have been extensively measured, assessed, modelled and described in previous noise studies (Golder Associates Report 1302793 – 10712 – 16 (July 2014) 'Environmental Impact Assessment for Sasol PSA and LPG Project - Noise Impact Assessment' and 1659075-306943 (September 2016) 'Integrated Environmental and Social Baseline Report – The Industrial Park'. This information was revisited and, where applicable, used as part of the present noise study. The noise emissions from the planned LGP project in the area were specifically included in the modelling process.

The potential noise impacts caused by the construction of the proposed PSA and LPG project and a proposed light industrial park were also the subject of previous studies and described in Impacto Report 'Addendum to the Environmental Impact Assessment (EIA) for the Sasol Petroleum Sharing Agreement (PSA) and Liquid Petroleum Gas (LPG) project – Temporary Camp Facilities at Pande' and Golder Associates Report 1659075-306943 (September 2016). The extent of the above project noise impacts was determined as very limited and were therefore, not included in the present CTT noise study.

At the time of this noise study, no specific technical details on the implementation of the investigated technologies, i.e. OCGE gas engine vs CCGT turbine, were available. Therefore, time was spent on gathering information on typical equipment noise emission levels, dimensions and acoustic properties of equipment housing and the noise reduction provided by air intake, exhaust and cooling fan silencers and the cladding of buildings. Based on the gathered information, a number of assumptions had to be made which are described in section 4.2.4 of this report.

### 4.2.2 Field study method

As described in section 4.2.1 of this report, detailed ambient noise measurements were conducted and modelled over a period of several years. A field visit was recently completed during which tests were performed that confirmed the various conditions from previous studies. Therefore, the full conclusions from those studies were assumed to be consistent. The CTT pre-development ambient noise levels are reproduced for reference purposes in Figures 9 and 10.

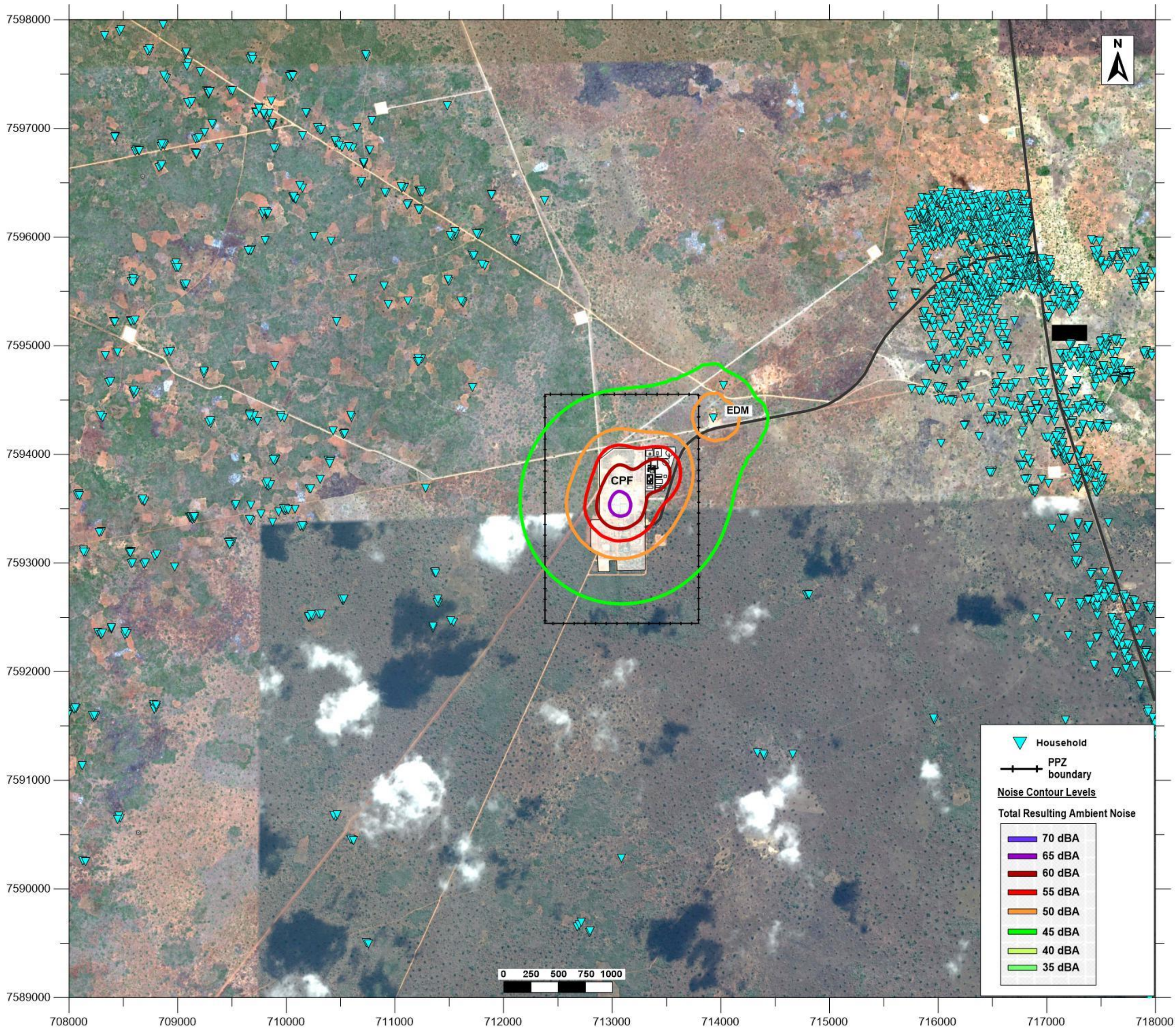


**Figure 9: CTT pre-development ambient noise levels during the day.**

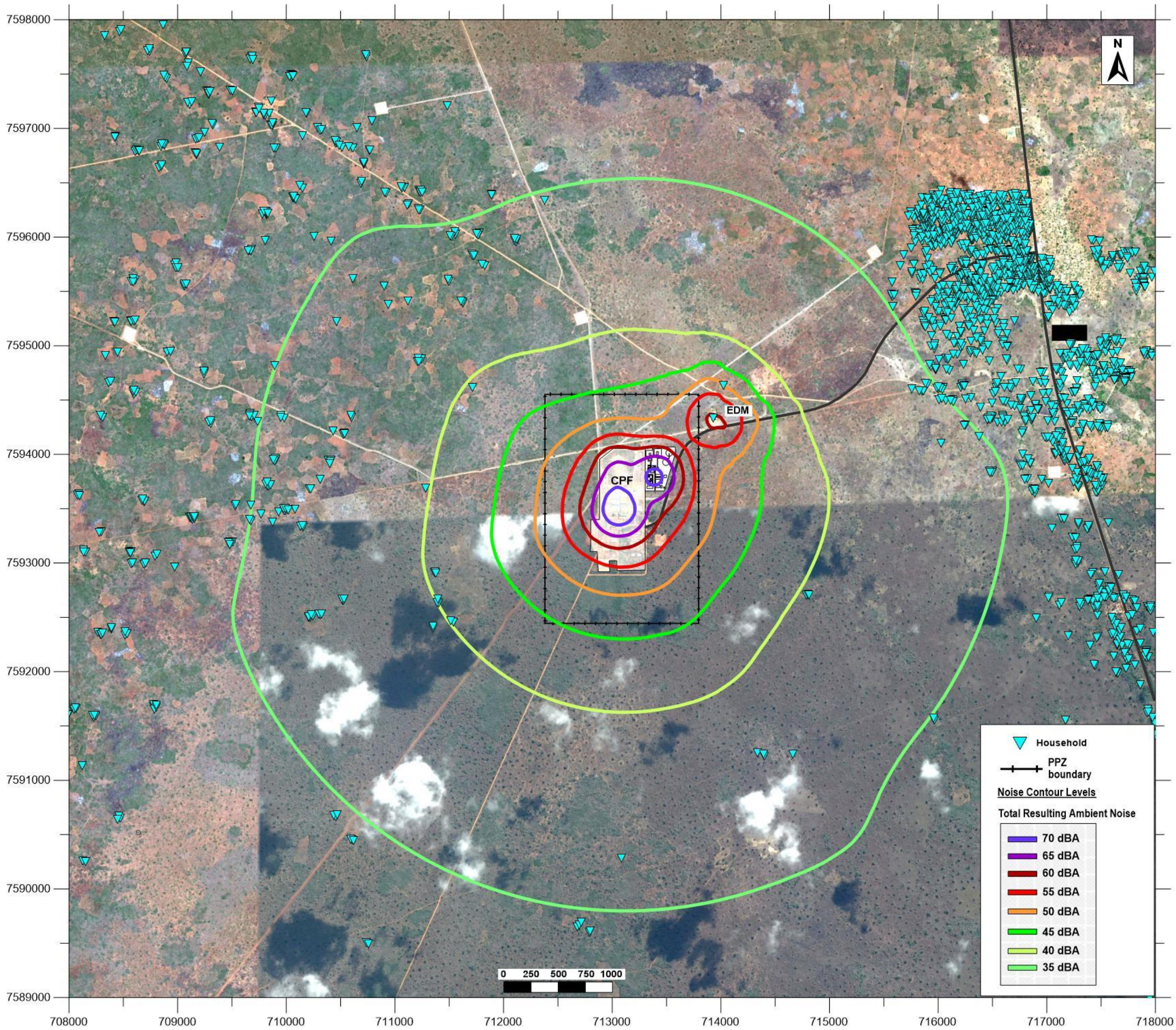


**Figure 10: CTT pre-development ambient noise levels during the night.**

### 4.2.3 Modelling

A three-dimensional model was developed that took account of the following aspects:

- The noise emissions from equipment and buildings during construction and operation;
- The attenuation of propagating noise energy as a result of:
  - Geometrical spreading over distance;
  - Absorption by the air and ground;
  - Acoustic screening by buildings; and
- The effect of diurnal meteorological and other atmospheric conditions.

The propagation of noise was calculated in accordance with the CONCAWE method, as described in South African National Standard (SANS) 10357.

### 4.2.4 Assumptions made for modelling

As mentioned in section 4.2.1 of this report, a number of assumptions had to be made for the modelling and calculation process. The required data for typical equipment noise emissions, enclosing buildings and silencers were obtained from project reports and published data sheets.

The assumptions are summarised in Table 1 for the open cycle gas engine and gas turbine options.

**Table 1: Assumptions made for the OCGE Gas Engine and CCGT Turbine options**

| Item | Gas Engine Option | CCGT Option |
|---|---|---|
| Number of power trains | 3 | 3 |
| Number of engines/turbines | 24 (8 per train) | 12 (2x gas + 2x steam per train) |
| Noise data engines/turbines | Wärtsilä 50GS generator set 18 MW | GE 9FA+e turbines, Hitachi heat recovery systems, up to 470 MW |
| Cooling/Fin Fans | 2x6 per engine set, mounted on the roof of the enclosures | 26 units per train |
| Project information source | Proposed Wärtsilä Anixas Power Plant in Walvis Bay, Namibia | Spalding Energy Extension, Lincolnshire, UK |
| Cladding of buildings | Sandwich structure: 0.7 mm steel – 100 mm mineral wool – 0.7 mm steel | Not specified. Noise emissions specified in terms of sound power radiation from plan view areas. |

Apart from those listed in Table 1, the following assumptions were made:

- The meteorological data used in the CPF noise impact study are also representative of current conditions;
- The assumed equipment noise emission levels are representative of those that will be used during construction and operation of the CTT;
- During construction, the maximum noise emissions will occur during ground clearing, earthworks and preparation of infrastructure platforms; and
- Construction and decommissioning will only take place during the hours of daylight.

### 4.2.5 Presentation of the modelling results

The modelling results are expressed in terms of the resulting total increase in ambient noise levels caused by the noise emissions from the CTT plant and is presented in terms of noise contours projected on a georeferenced satellite image.

A mentioned in section 3 of this report, the WHO recommends ambient noise levels of 55 dBA and 45 dBA determined over the period of day- and night-time, respectively. Therefore, these noise levels serve as criteria for assessing the noise impacts expressed in terms of the resulting total resulting ambient noise levels.

Both the World Bank (WB) and International Finance Corporation (IFC) also specify to the 55 dBA and 45 dBA determined over the period of day- and night-time, respectively. However, they add an additional criterion which specifies that the increase in ambient noise levels should not exceed 3 dB.

Table 5 of SANS 10103 provides a guideline for estimating community response to an increase in the general ambient noise level caused by an intruding noise. If Δ is the increase in noise level, the following criteria are of relevance:

- Δ ≤ 0 dB: An increase of 0 dB or less will not cause any response from a community. Any increase of less than 1 dB is negligible. For a person with average hearing acuity an increase of less than 3 dB in the general ambient noise level will not be noticeable. Therefore, 3 dB is a useful ‘significance indicator’ that will be used in this study to assess whether a noise impact is significant or not;

- 0 dB < Δ ≤ 10 dB: An increase of between 0 dB and 10 dB will elicit ‘little’ community response with ‘sporadic complaints’. However, between 5 dB and 15 dB the strength of the response will gradually change to ‘medium’ with ‘widespread complaints’;
- 5 dB < Δ ≤ 15 dB: An increase of between 5 dB and 15 dB will elicit a ‘medium’ community response with ‘widespread complaints’. It is also worth noting that an increase of 10 dB is subjectively perceived as a doubling in the loudness of a noise. For an increase of more than 15 dB the community reaction will be ‘strong’ with ‘threats of community action’;
- 15 dB < Δ: For an increase in excess of 15 dB the community response will gradually increase in strength to ‘very strong’ with ‘vigorous community action’; and
- 10 dB < Δ ≤ 20 dB: For an increase of between 10 dB and 20 dB the community response will gradually increase in strength to ‘strong’ with ‘threats of community action’;

The overlapping ranges of community responses reflect the fact that there is no clear-cut transition from one community response to another. Instead the transition is more gradual and may differ substantially from one scenario to another, depending on a large number of variables.

# 5.0 IMPACT ASSESSMENT

## 5.1 Assessment methodology and rating criteria

Potential impacts are assessed according to the direction, intensity (or severity), duration, extent and probability of occurrence of the impact. These criteria are discussed in more detail below:

**Direction of an impact** may be positive, neutral or negative with respect to the particular impact. A positive impact is one which is considered to represent an improvement on the baseline or introduces a positive change. A negative impact is an impact that is considered to represent an adverse change from the baseline or introduces a new undesirable factor.

**Intensity / Severity** is a measure of the degree of change in a measurement or analysis (e.g. the concentration of a metal in water compared to the water quality guideline value for the metal), and is classified as none, negligible, low, moderate or high. The categorisation of the impact intensity may be based on a set of criteria (e.g. health risk levels, ecological concepts and/or professional judgment). The specialist study must attempt to quantify the intensity and outline the rationale used. Appropriate, widely-recognised standards are used as a measure of the level of impact.

**Duration** refers to the length of time over which an environmental impact may occur: i.e. transient (less than 1 year), short-term (1 to 5 years), medium term (6 to 15 years), long-term (greater than 15 years with impact ceasing after closure of the project) or permanent.

**Scale/Geographic extent** refers to the area that could be affected by the impact and is classified as site, local, regional, national, or international. The reference is not only to physical extent but may include extent in a more abstract sense, such as an impact with regional policy implications which occurs at local level.

**Probability of occurrence** is a description of the probability of the impact actually occurring as improbable (less than 5% chance), low probability (5% to 40% chance), medium probability (40 % to 60 % chance), highly probable (most likely, 60% to 90% chance) or definite (impact will definitely occur).

**Impact significance** will be rated using the scoring system shown in Table 2 below The significance of impacts is assessed for the two main phases of the project: i) construction ii) operations. While a somewhat subjective term, it is generally accepted that significance is a function of the magnitude of the impact and the likelihood (probability) of the impact occurring. Impact magnitude is a function of the extent, duration and severity of the impact, as shown in Table 2.

**Table 2: Scoring system for evaluating impacts**

| Severity | Duration | Extent | Probability |
|---|---|---|---|
| 10 (Very high/don't know) | 5 (Permanent) | 5 (International) | 5 (Definite/don't know) |
| 8 (High) | 4 (Long-term – longer than 15 years and impact ceases after closure of activity) | 4 (National) | 4 (Highly probable) |
| 6 (Moderate) | 3 (Medium-term- 6 to 15 years) | 3 (Regional) | 3 (Medium probability) |
| 4 (Low) | 2 (Short-term - 1 to 5 years) | 2 (Local) | 2 (Low probability) |
| 2 (Minor) | 1 (Transient – less than 1 year) | 1 (Site) | 1 (Improbable) |
| 1 (None) | | | 0 (None) |

After ranking these criteria for each impact, a significance rating was calculated using the following formula:

**SP (significance points) = (severity + duration + extent) x probability.**

The maximum value is 100 significance points (SP). The potential environmental impacts were then rated as of High (SP >75), Moderate (SP 46 – 75), Low (SP ≤15 - 45) or Negligible (SP < 15) significance, both with and without mitigation measures in accordance with Table 3.

**Table 3: Impact significance rating**

| Value | Significance | Comment |
|---|---|---|
| **SP >75** | Indicates **high** environmental significance | Where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resource/receptors. Impacts of high significance would typically influence the decision to proceed with the project. |
| **SP 46 - 75** | Indicates **moderate** environmental significance | Where an effect will be experienced, but the impact magnitude is sufficiently small and well within accepted standards, and/or the receptor is of low sensitivity/value. Such an impact is unlikely to have an influence on the decision. Impacts may justify significant modification of the project design or alternative mitigation. |
| **SP 15 - 45** | Indicates **low** environmental significance | Where an effect will be experienced, but the impact magnitude is small and is within accepted standards, and/or the receptor is of low sensitivity/value or the probability of impact is extremely low. Such an impact is unlikely to have an influence on the decision although impact should still be reduced as low as possible, particularly when approaching moderate significance. |
| **SP < 15** | Indicates **negligible** environmental significance | Where a resource or receptor will not be affected in any material way by a particular activity or the predicted effect is deemed to be imperceptible or is indistinguishable from natural background levels. No mitigation is required. |
| **+** | **Positive impact** | Where positive consequences / effects are likely. |

In addition to the above rating criteria, the terminology used in this assessment to describe impacts arising from the current project are outlined in Table 4 below. In order to fully examine the potential changes that the project might produce, the project area can be divided into Areas of Direct Influence (ADI) and Areas of Indirect Influence (AII).

- Direct impacts are defined as changes that are caused by activities related to the project and they occur at the same time and place where the activities are carried out i.e. within the ADI.
- Indirect impacts are those changes that are caused by project-related activities, but are felt later in time and outside the ADI. The secondary indirect impacts are those which are as a result of activities outside of the ADI.

**Table 4: Types of impact**

| Term for Impact Nature | Definition |
|---|---|
| Direct impact | Impacts that result from a direct interaction between a planned project activity and the receiving environment/receptors (i.e. between an effluent discharge and receiving water quality). |
| Indirect impact | Impacts that result from other activities that are encouraged to happen as a consequence of the Project (i.e., pollution of water placing a demand on additional water resources). |
| Cumulative impact | Impacts that act together with other impacts (including those from concurrent or planned activities) to affect the same resources and/or receptors as the Project. |

## 5.2 Identified impacts - Open Cycle Gas Engines

The identified impacts for the Open Cycle Gas Engine (OCGE) option are:

- The resulting total ambient noise levels caused by CTT noise emissions at households may be in excess of WHO recommendations and the increase in ambient noise levels in excess of the IFC recommendation;
- Communities reacting to increase in ambient noise levels caused by CTT noise emissions when assessed against the recommendations given in Table 5 of SANS 10103:2008;
- During night-time, when meteorological and atmospheric conditions favour the propagation of noise, it's intrusion into households may cause sleep disturbance; and
- During the construction phase the transport of equipment from the beach landing site and via the EN1 will cause single noise events, i.e. events of relatively short duration.

Noise is per definition a negative phenomenon, i.e. unwanted sound, and its effect is cumulative since it adds to existing noise conditions.

### 5.2.1 Construction phase impacts

The noise impact expressed in terms of the resulting total and the increase in ambient noise levels are presented in Figures 11 and 12, respectively.

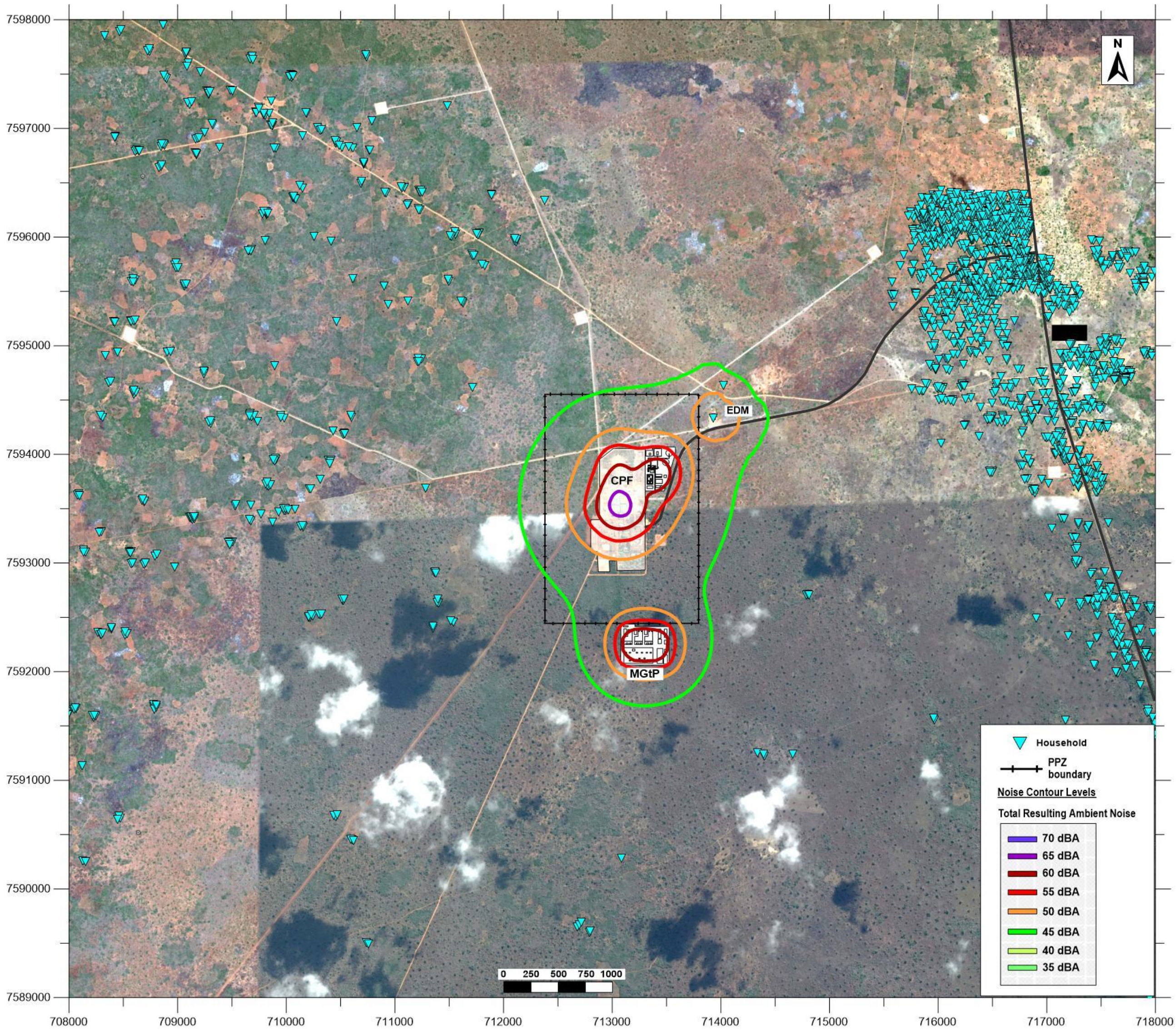


**Figure 11: Noise impact expressed as contours of the resulting total ambient noise levels during construction.**

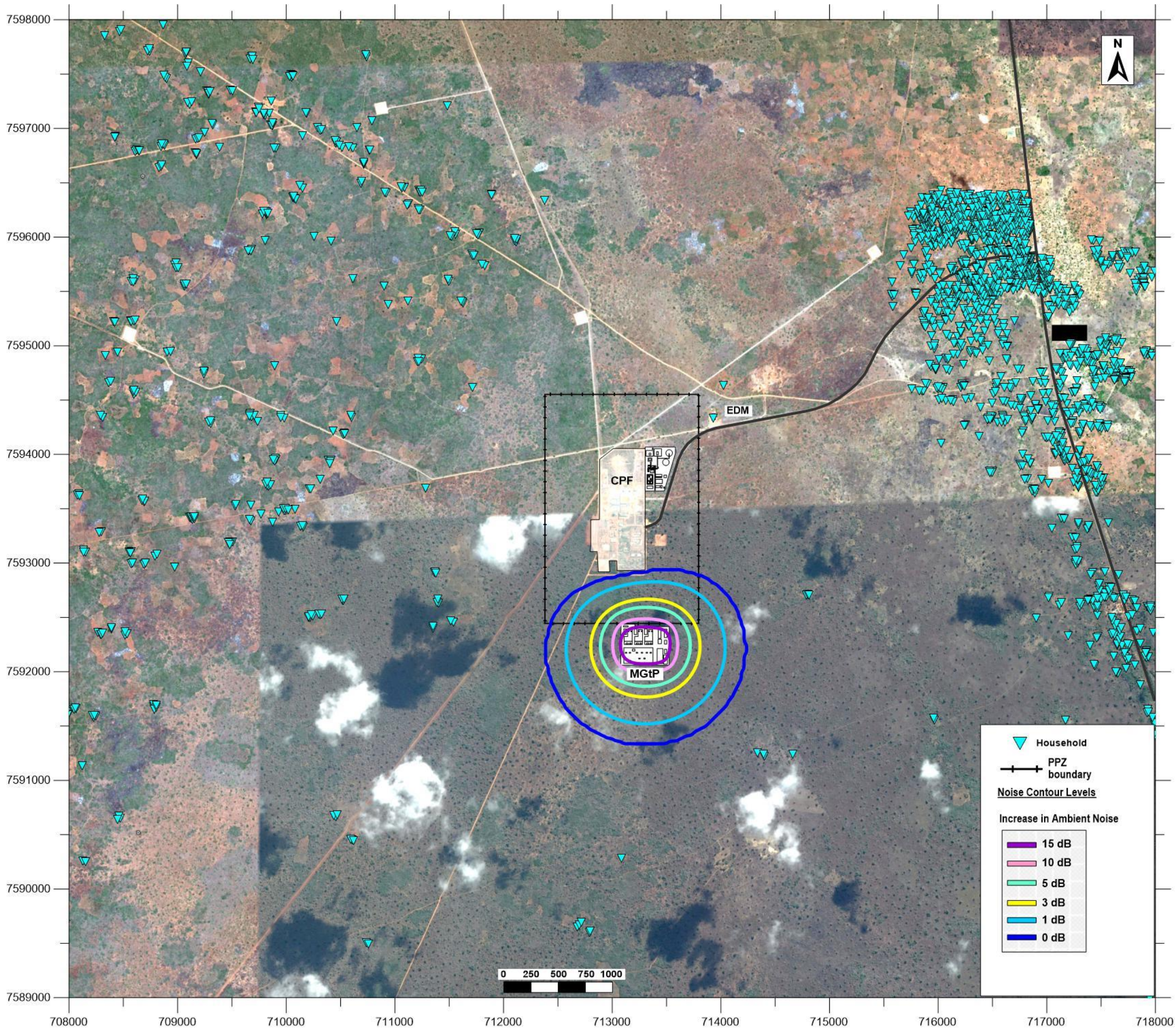


**Figure 12: Noise impact expressed as contours of the increase in ambient noise levels during construction.**

The following remarks are of relevance to the results given in Figures 11 and 12:

- The results in Figure 11 clearly show that the extent of the 55 dBA contour is limited to the immediate vicinity of the CTT construction site and that no households will be affected;
- The results in Figure 12 show that the contours of significant increases in ambient noise level, i.e. in excess of 3 dB, are limited to the immediate vicinity of the CTT construction site. No households will be affected;
- The noise contours for transportation were not calculated due to their low frequency of occurrence and short event durations. The extent of their impacts will be limited to the immediate proximity of roads;
- According to Table 5 of SANS 10103 there will be no community response to the increase in ambient noise levels during construction.

Due to the fact that no households will be affected during construction and based on the assumption that activities will be restricted to the hours of daylight no specific mitigation measures are required.

**Table 5: Cumulative noise impact during the construction phase (Gas Engine option)**

| Indicator of potential impact | Pre-mitigation | | | | | Post-mitigation | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Magnitude | Duration | Geographic Extent | Probability | Significance | Magnitude | Duration | Geographic Extent | Probability | Significance |
| *Resulting total ambient noise levels* | 1 | 2 | 1 | 3 | **Negligible 12** | 1 | 2 | 1 | 3 | **Negligible 12** |
| *Increase in ambient noise levels* | 1 | 2 | 1 | 3 | **Negligible 12** | 1 | 2 | 1 | 3 | **Negligible 12** |
| *Sleep disturbance* | 1 | 1 | 1 | 0 | **Negligible 0** | 1 | 1 | 1 | 0 | **Negligible 0** |
| *Transportation noise events* | 1 | 2 | 1 | 4 | **Low 16** | 1 | 2 | 1 | 4 | **Low 16** |

### 5.2.2 Operational phase impacts

The noise impact expressed in terms of the resulting total and the increase in ambient noise levels during day- and night-time are presented in Figures 13 to 16.

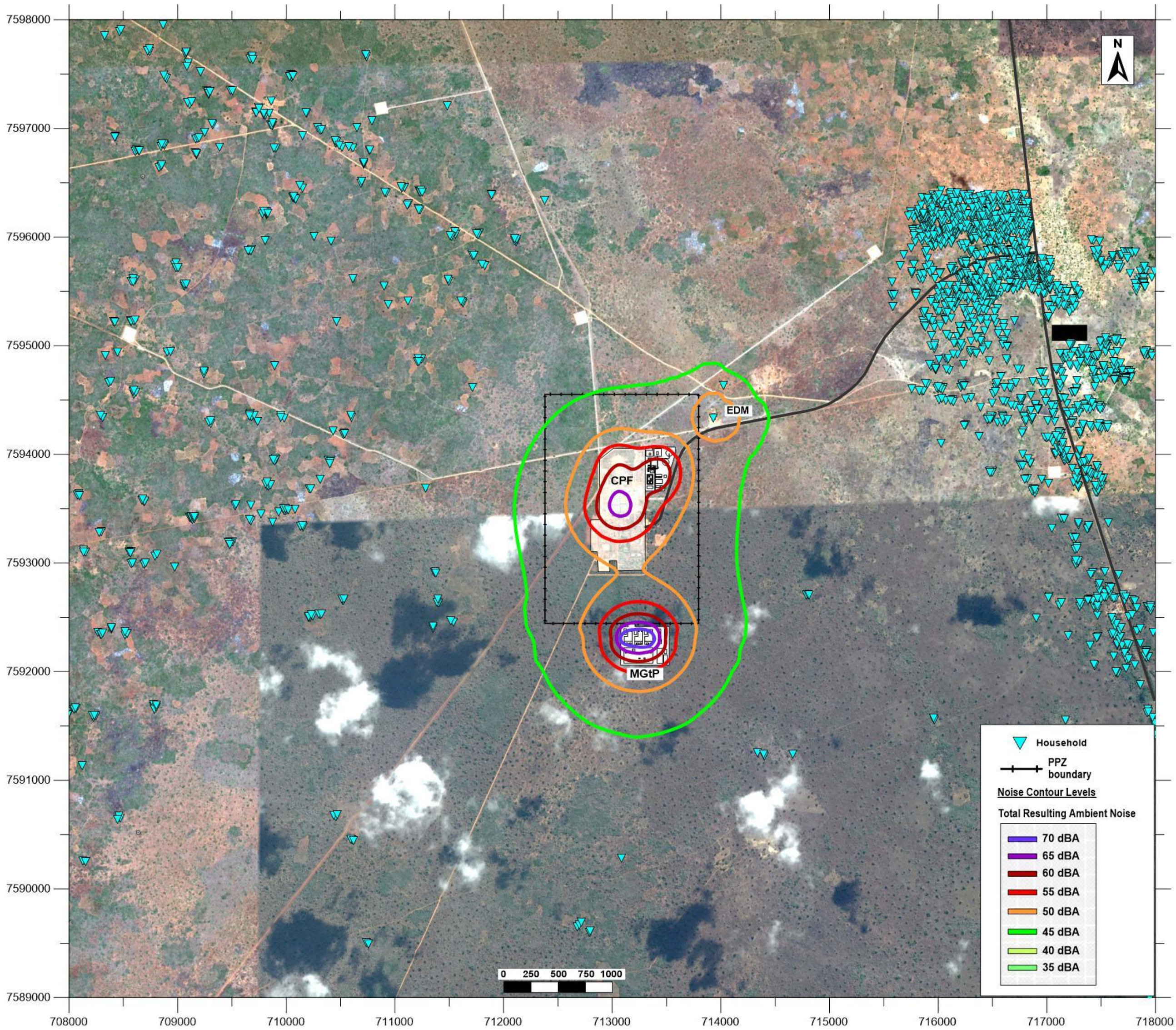


**Figure 13: Day-time noise impact expressed as contours of the resulting total ambient noise levels during operation.**

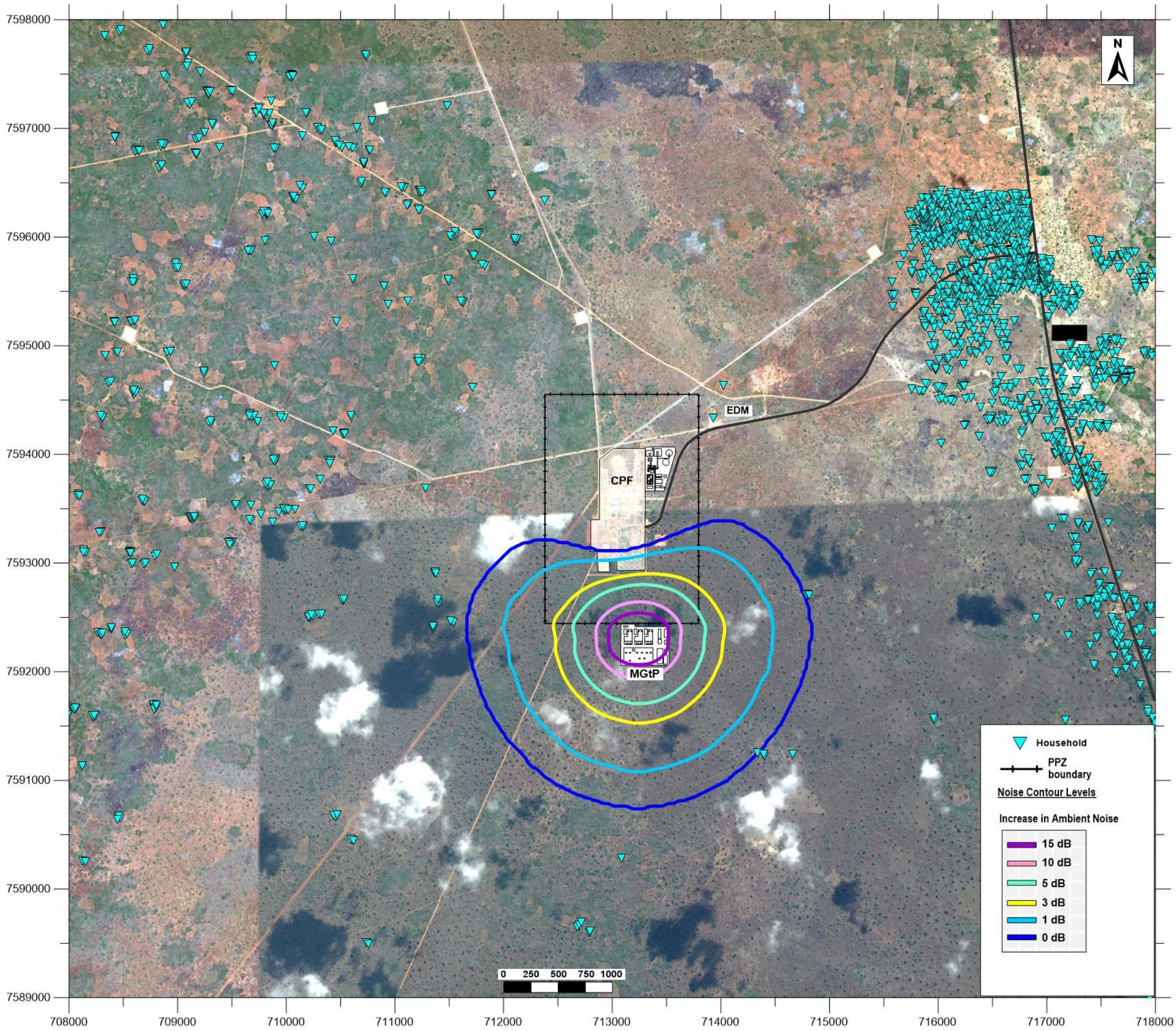


**Figure 14: Day-time noise impact expressed as contours of the increase in ambient noise levels during operation.**

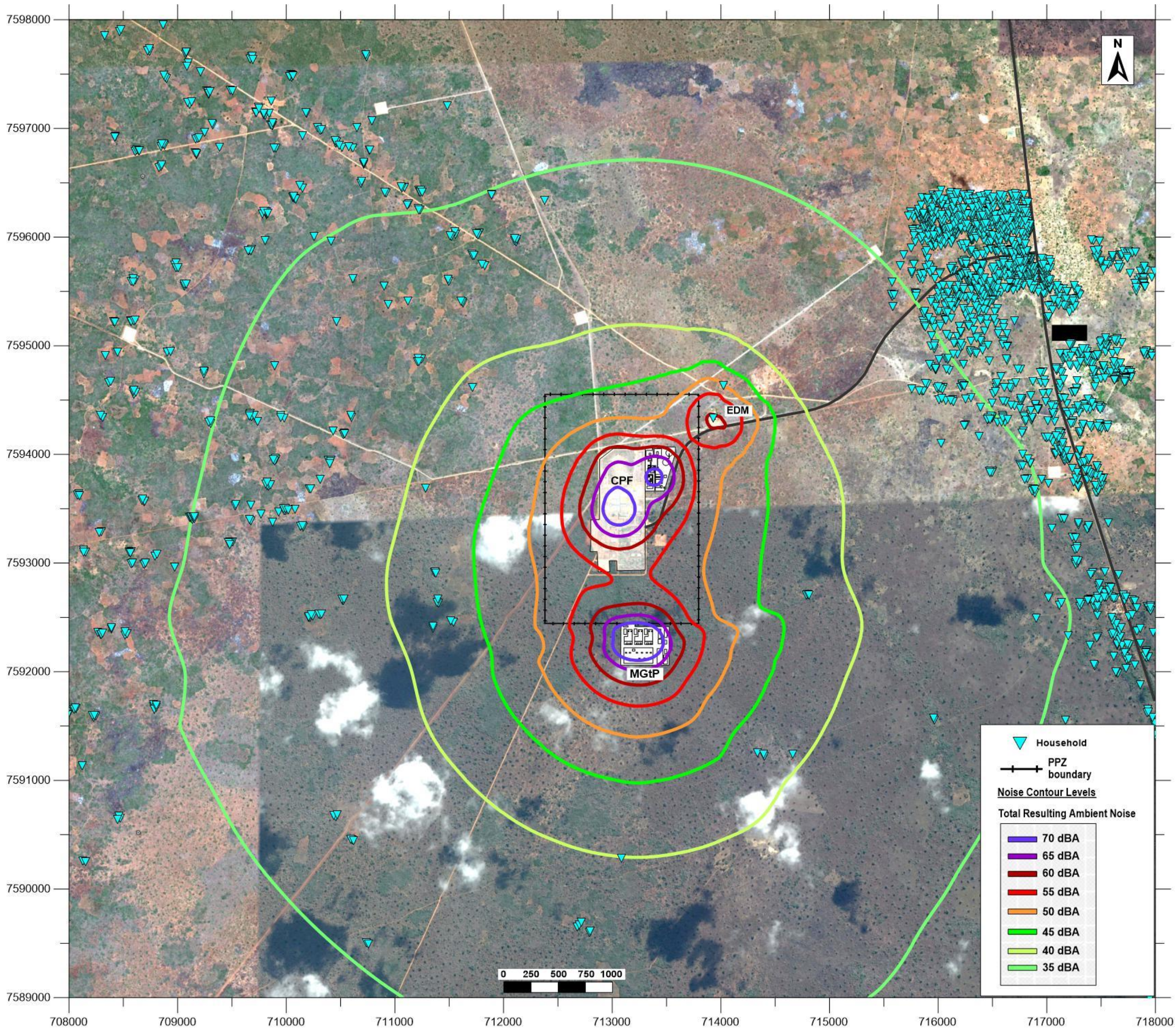


**Figure 15: Night-time noise impact expressed as contours of the resulting total ambient noise levels during operation.**

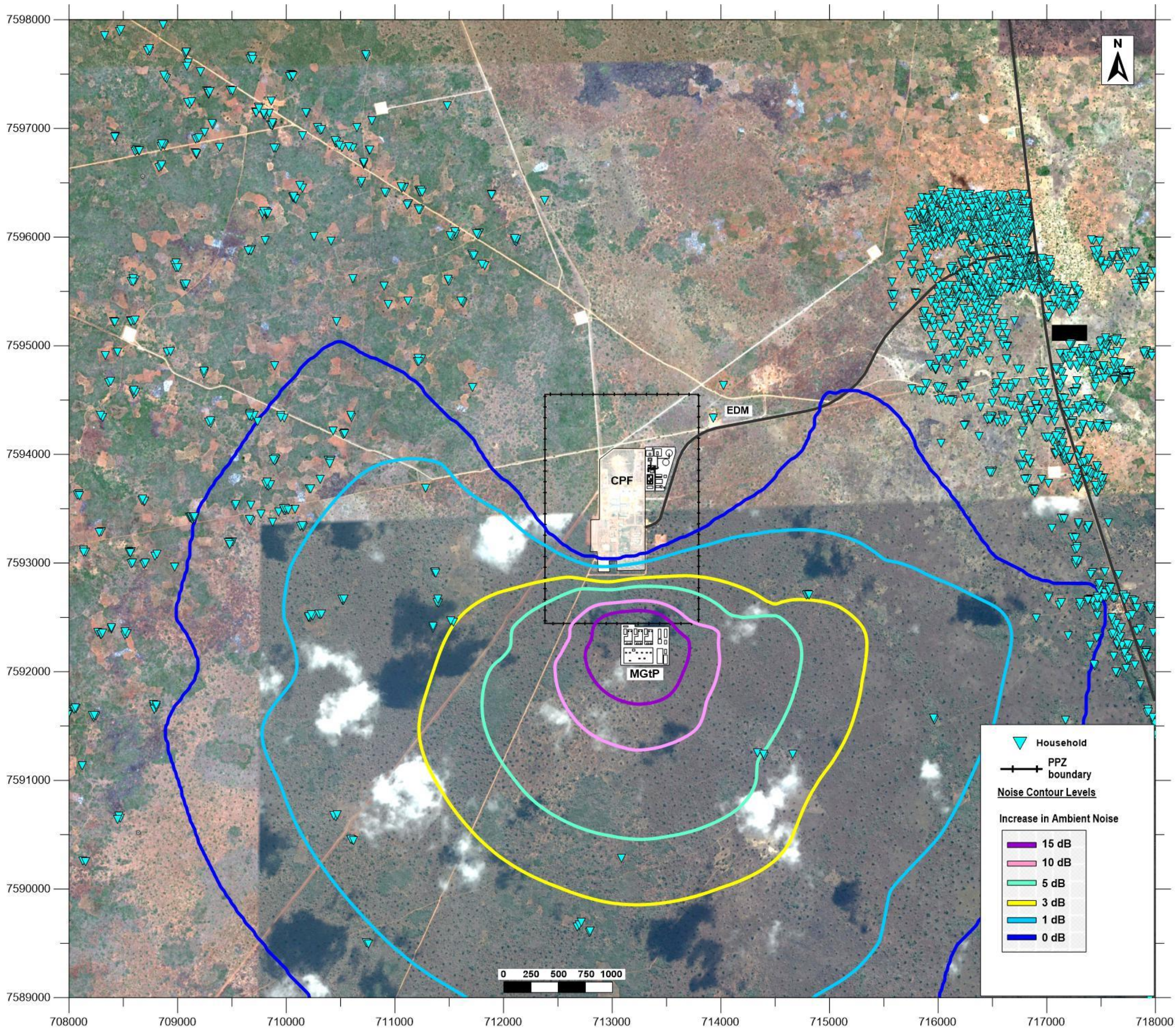


**Figure 16: Night-time noise impact expressed as contours of the increase in ambient noise levels during operation.**

The following remarks are of relevance to the results given in Figures 13 to 16:

- During day-time the contours of the resulting total ambient noise levels of 55 dBA are located in close proximity of the CTT plant, and no households are included by it (see Figure 13). Therefore, the recommendation of the WHO for residential areas is fulfilled;
- During day-time the 3 dB contour, which serves as a significance indicator, does not affect any households thereby satisfying the recommendation of the WB and IFC (see Figure 14);
- During night-time the extent of the noise impact contours is considerably further than during day-time. The reason for this is that meteorological and other atmospheric conditions enhance the propagation of noise over longer distances;
- However, in terms of the resulting total ambient noise levels no households fall within the 45 dBA contour (see Figure 15) and the recommendation of the WHO for residential areas during night-time is met;

- In terms of the increase in ambient noise levels four households fall within the 3 dB contour, i.e. they will experience a significant noise impact (see Figure 16). However, this must be evaluated in view of the total resulting ambient noise level, that will be well below the levels recommended by the WHO and IFC. A larger number of households will experience insignificant to negligible noise impact; and
- According to Table 5 of SANS 10103 the community response to the increase in ambient noise levels will be 'little' with 'sporadic complaints'.

Further analysis shows that the extent of the noise impact is largely determined by the noise emissions from the cooling fans. Therefore, if mitigation measures are to be considered the noise emissions from these fans need to be reduced.

In view of the absence of further technical details it was not meaningful to further investigate the application of any noise control measures on the cooling fans.

**Table 6: Cumulative DAY-TIME noise impact during the operational phase (Gas Engine option)**

| Indicator of potential impact | Pre-mitigation | | | | | Post-mitigation | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Magnitude | Duration | Geographic Extent | Probability | Significance | Magnitude | Duration | Geographic Extent | Probability | Significance |
| *Resulting total ambient noise levels* | 1 | 2 | 1 | 3 | Negligible 12 | 1 | 2 | 1 | 3 | Negligible 12 |
| *Increase in ambient noise levels* | 1 | 2 | 1 | 3 | Negligible 12 | 1 | 2 | 1 | 3 | Negligible 12 |
| *Sleep disturbance* | 1 | 1 | 1 | 0 | Negligible 0 | 1 | 1 | 1 | 0 | Negligible 0 |

**Table 7: Cumulative NIGHT-TIME noise impact during the operational phase (Gas Engine option)**

| Indicator of potential impact | Pre-mitigation | | | | | Post-mitigation | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Magnitude | Duration | Geographic Extent | Probability | Significance | Magnitude | Duration | Geographic Extent | Probability | Significance |
| *Resulting total ambient noise levels* | 2 | 4 | 2 | 4 | Low 32 | 2 | 4 | 2 | 4 | Low 32 |
| *Increase in ambient noise levels* | 4 | 4 | 2 | 4 | Low 40 | 6 | 4 | 2 | 4 | Low 40 |
| *Sleep disturbance* | 1 | 4 | 2 | 1 | Negligible 7 | 1 | 4 | 2 | 1 | Negligible 7 |

### 5.2.3 Decommissioning phase impacts

Decommissioning will entail the dismantling of infrastructure, removal of equipment and earthworks to reshape and rehabilitate the terrain. Therefore, it is assumed that the noise impact will be very similar to or less than that occurring during the construction phase.

**Table 8: Cumulative DAY-TIME noise impact during the decommissioning phase (Gas Engine option)**

| Indicator of potential impact | Pre-mitigation | | | | | Post-mitigation | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Magnitude | Duration | Geographic Extent | Probability | Significance | Magnitude | Duration | Geographic Extent | Probability | Significance |
| *Resulting total ambient noise levels* | 1 | 2 | 1 | 3 | Negligible 12 | 1 | 2 | 1 | 3 | Negligible 12 |
| *Increase in ambient noise levels* | 1 | 2 | 1 | 3 | Negligible 12 | 1 | 2 | 1 | 3 | Negligible 12 |
| *Sleep disturbance* | 1 | 1 | 1 | 0 | Negligible 0 | 1 | 1 | 1 | 0 | Negligible 0 |

## 5.3 Identified impacts - Combined Cycle Gas Turbine

The identified impacts of the Combined Cycle Gas Turbine option are:

- The resulting total ambient noise levels caused by CTT noise emissions at households may be in excess of WHO recommendations;
- Communities reacting to increase in ambient noise levels caused by CTT noise emissions;
- During night-time, when meteorological and atmospheric conditions favour the propagation of noise, it’s intrusion into households may cause sleep disturbance; and
- During the construction phase the transport of equipment from the beach landing site and via the EN1 will cause single noise events, i.e. events of relatively short duration.

Noise is per definition a negative phenomenon, i.e. unwanted sound, and its effect is cumulative since it adds to existing noise conditions.

### 5.3.1 Construction phase impacts

At the time of writing this report it has to be assumed that the noise impact during the construction of the CCGT will be the same as for the OCGE option. Therefore, the assessment will be the same.

**Table 9: Cumulative noise impact during the construction phase (Gas Engine option)**

| Indicator of potential impact | Pre-mitigation | | | | | Post-mitigation | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Magnitude | Duration | Geographic Extent | Probability | Significance | Magnitude | Duration | Geographic Extent | Probability | Significance |
| *Resulting total ambient noise levels* | 1 | 2 | 1 | 3 | Negligible 12 | 1 | 2 | 1 | 3 | Negligible 12 |
| *Increase in ambient noise levels* | 1 | 2 | 1 | 3 | Negligible 12 | 1 | 2 | 1 | 3 | Negligible 12 |
| *Sleep disturbance* | 1 | 1 | 1 | 0 | Negligible 0 | 1 | 1 | 1 | 0 | Negligible 0 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| *Transportation noise events* | 1 | 2 | 1 | 4 | **Low 16** | 1 | 2 | 1 | 4 | **Low 16** |

### 5.3.2 Operational phase impacts

The noise impact expressed in terms of the resulting total and the increase in ambient noise levels during day- and night-time are presented in Figures 17 to 20.

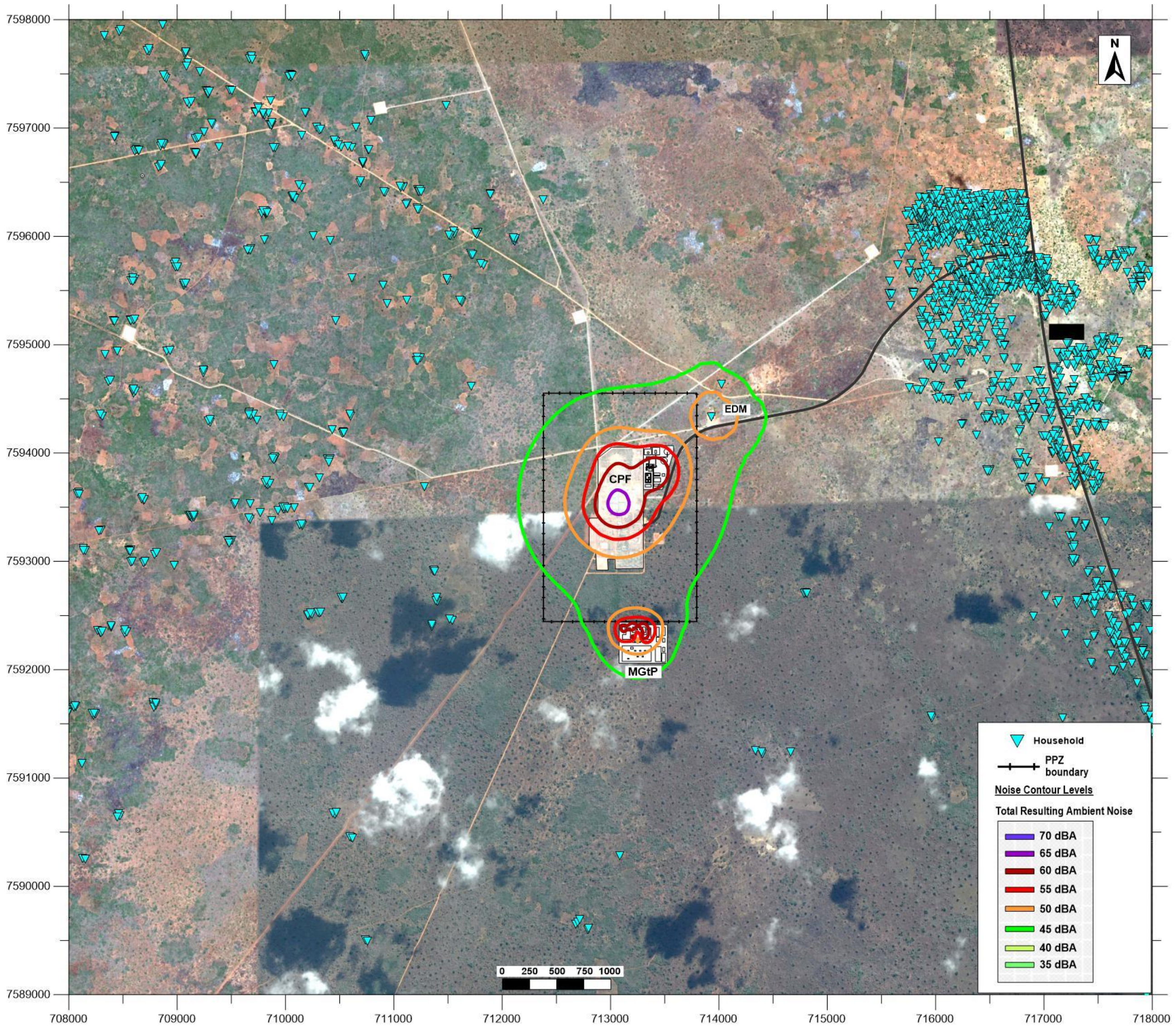


**Figure 17: CCGT day-time noise impact expressed as contours of the resulting total ambient noise levels during operation.**

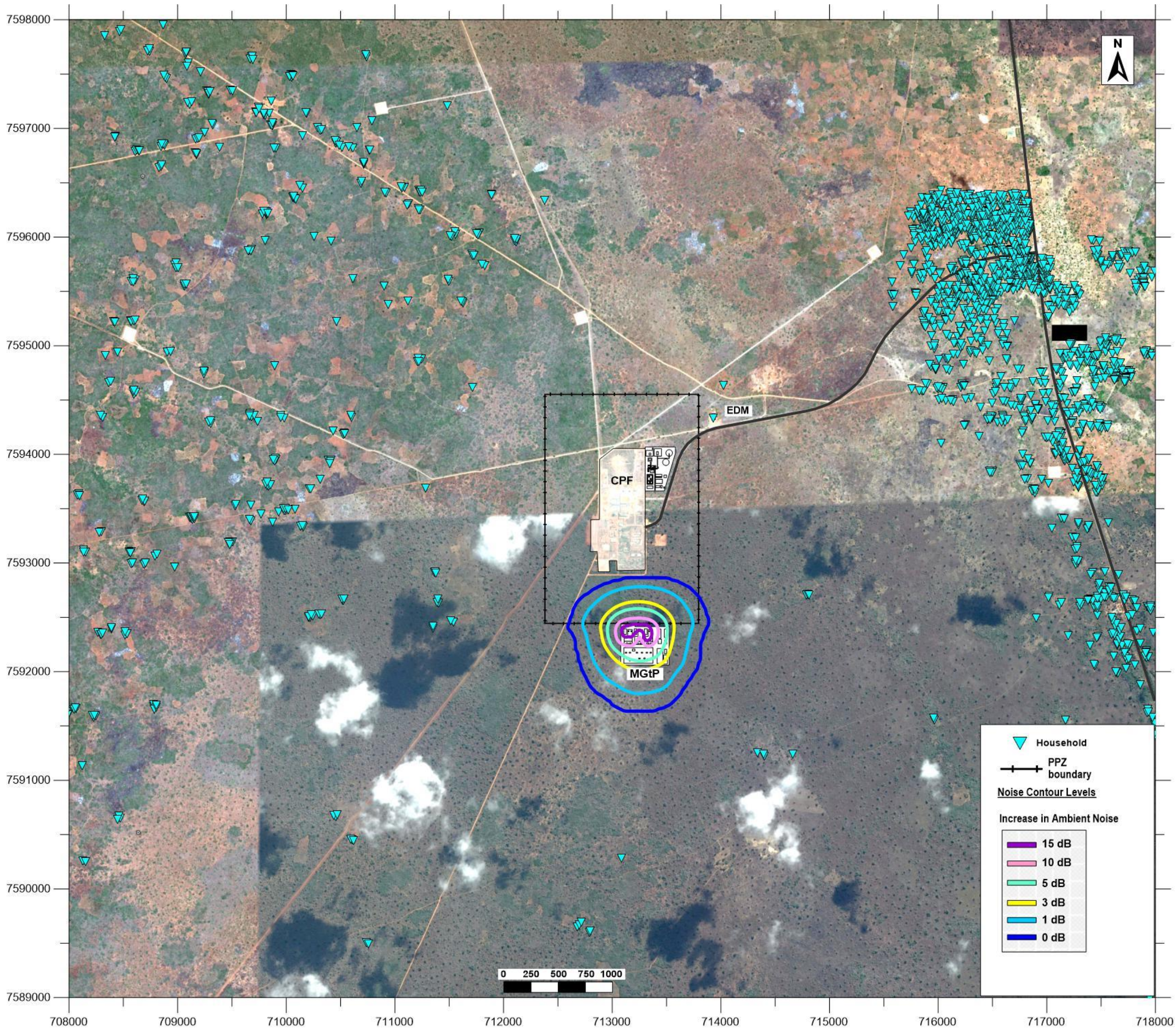


**Figure 18: CCGT day-time noise impact expressed as contours of the increase in ambient noise levels during operation.**

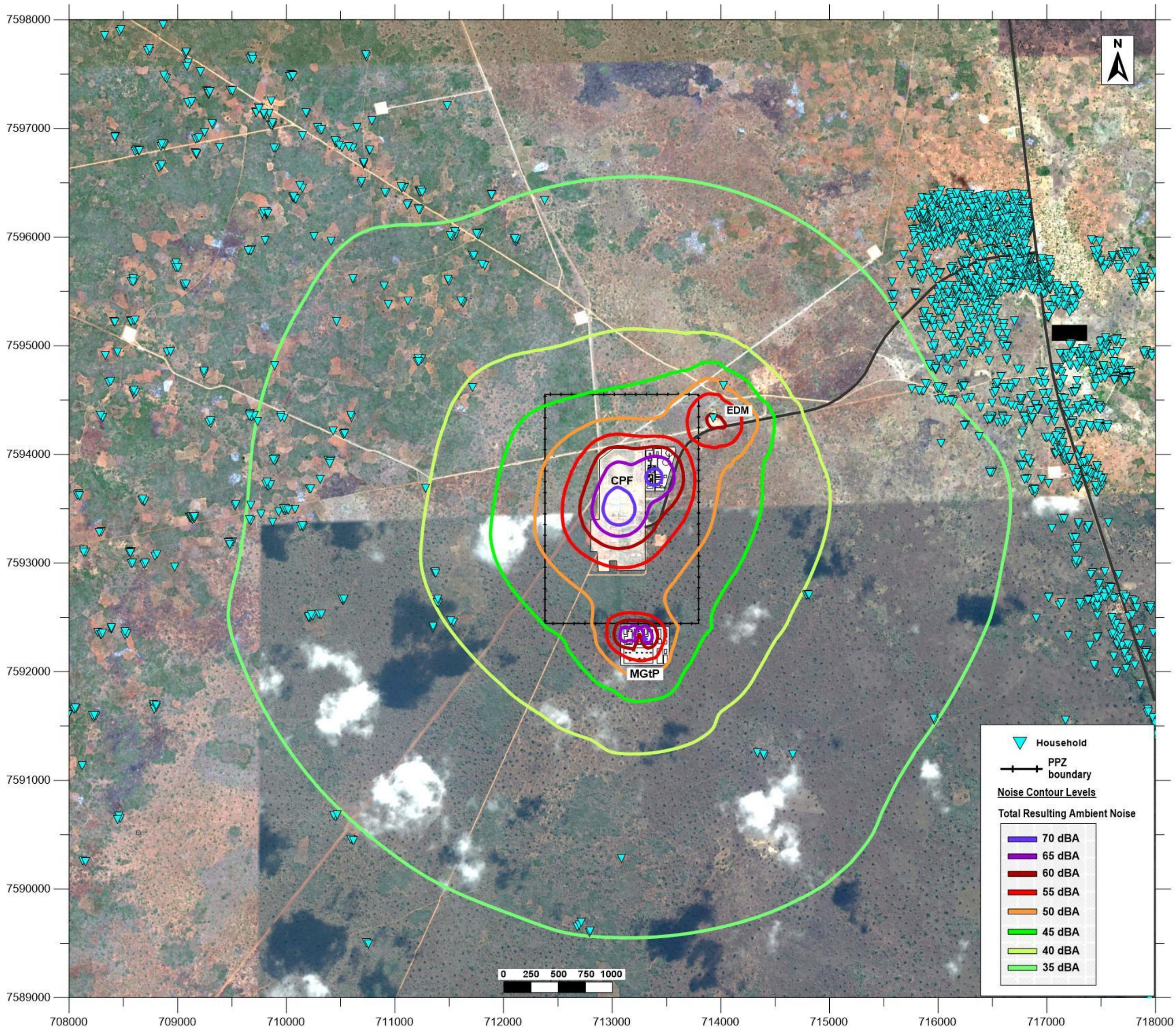


**Figure 19: CCGT night-time noise impact expressed as contours of the resulting total ambient noise levels during operation.**

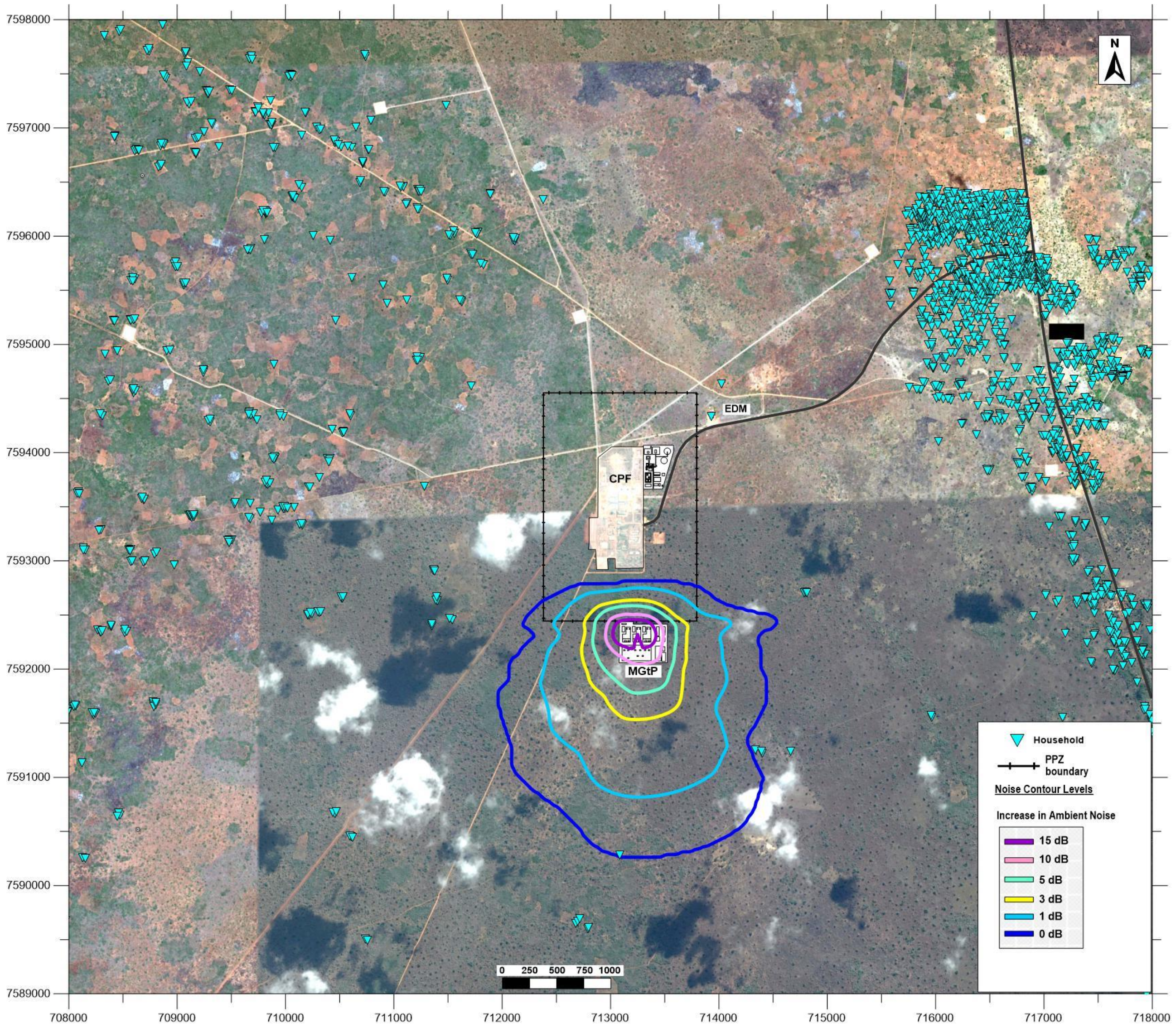


**Figure 20: CCGT night-time noise impact expressed as contours of the increase in ambient noise levels during operation.**

The following remarks are of relevance to the results given in Figures 17 to 20:

- Comparison between the corresponding day- and night-time results of the OCGE and CCGT options shows that the extent of the noise impact caused by the CCGT is considerably less than for the OCGE option, especially during the night;
- During day-time no households are affected by the 55 dBA contour (see Figure 17). Therefore, the recommendation of the WHO for residential areas is fulfilled;
- During day-time the 3 dB contour is in close proximity to the CCGT and does not affect any households thereby satisfying the recommendation of the WB and IFC (see Figure 18);
- Although the noise impact contours extend further during night-time no households fall within the 45 dBA contour (see Figure 15) and the recommendation of the WHO for residential areas during night-time is met;
- In terms of the increase in ambient noise levels no households fall within the 3 dB contour;

- Therefore, generally speaking the noise impact caused by the CCGT is significantly smaller than by the OCGE; and
- According to Table 5 of SANS 10103 there will be no community reaction to the increase in ambient noise levels.

**Table 10: Cumulative DAY-TIME noise impact during the operational phase (CCGT option)**

| Indicator of potential impact | Pre-mitigation | | | | | Post-mitigation | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Magnitude | Duration | Geographic Extent | Probability | Significance | Magnitude | Duration | Geographic Extent | Probability | Significance |
| *Resulting total ambient noise levels* | 1 | 2 | 1 | 3 | Negligible 12 | 1 | 2 | 1 | 3 | Negligible 12 |
| *Increase in ambient noise levels* | 1 | 2 | 1 | 3 | Negligible 12 | 1 | 2 | 1 | 3 | Negligible 12 |
| *Sleep disturbance* | 1 | 1 | 1 | 0 | Negligible 0 | 1 | 1 | 1 | 0 | Negligible 0 |

**Table 11: Cumulative NIGHT-TIME noise impact during the operational phase (CCGT option)**

| Indicator of potential impact | Pre-mitigation | | | | | Post-mitigation | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Magnitude | Duration | Geographic Extent | Probability | Significance | Magnitude | Duration | Geographic Extent | Probability | Significance |
| *Resulting total ambient noise levels* | 1 | 2 | 1 | 3 | Negligible 12 | 1 | 2 | 1 | 3 | Negligible 12 |
| *Increase in ambient noise levels* | 1 | 2 | 1 | 3 | Negligible 12 | 1 | 2 | 1 | 3 | Negligible 12 |
| *Sleep disturbance* | 1 | 1 | 1 | 0 | Negligible 0 | 1 | 1 | 1 | 0 | Negligible 0 |

### 5.3.3 Decommissioning phase impacts

Decommissioning will entail the dismantling of infrastructure, removal of equipment and earthworks to reshape and rehabilitate the terrain. Therefore, it is assumed that the noise impact will be very similar to or less than that occurring during the construction phase.

**Table 12: Cumulative NIGHT-TIME noise impact during the decommissioning phase (CCGT option)**

| Indicator of potential impact | Pre-mitigation | | | | | Post-mitigation | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Magnitude | Duration | Geographic Extent | Probability | Significance | Magnitude | Duration | Geographic Extent | Probability | Significance |
| *Resulting total ambient noise levels* | 1 | 2 | 1 | 3 | **Negligible 12** | 1 | 2 | 1 | 3 | **Negligible 12** |
| *Increase in ambient noise levels* | 1 | 2 | 1 | 3 | **Negligible 12** | 1 | 2 | 1 | 3 | **Negligible 12** |
| *Sleep disturbance* | 1 | 1 | 1 | 0 | **Negligible 0** | 1 | 1 | 1 | 0 | **Negligible 0** |

# 6.0 ENVIRONMENTAL ACTION PLAN – VALID FOR BOTH GAS ENGINES AND GAS TURBINES

**Table 13: Environmental Action Plan - Gas Engines**

| Aspect | Potential Impact | Impact Source | Detailed Actions | Responsibility |
|---|---|---|---|---|
| *Construction Phase* | | | | |
| Noise emissions from the CTT site | Increase in ambient noise levels | Diesel powered earth moving equipment | 1) Ensure high quality and well-maintained equipment is used.<br>2) Activities conducted only during hours of daylight | Contractor |
| Transport of materials and equipment | Occurrence of single noise events | Heavy vehicles on public and access roads | 1) Vehicles are well maintained, especially exhaust silencers<br>2) Movement schedule of extra heavy transport from beach landing site published and adhered to | 1) Contractor<br>2) Project team |
| *Operational Phase* | | | | |
| Noise emissions from the CTT plant | Increase in ambient noise levels | 1) Cooling fans on the roof of building<br>2) Noise emissions from building façades and roof | 1) Alternative placement and/or design of cooling system<br>2) Cladding of buildings designed for optimum noise reduction<br>3) Minimisation of openings in façades | Design team |

| Aspect | Potential Impact | Impact Source | Detailed Actions | Responsibility |
|---|---|---|---|---|
| *Decommissioning Phase* | | | | |
| Noise emissions from the CTT site | Increase in ambient noise levels | Diesel powered earth moving equipment | 1) Ensure high quality and well-maintained equipment is used.<br>2) Activities conducted only during hours of daylight | Contractor |

# 7.0 MONITORING PROGRAMME – VALID FOR BOTH GAS ENGINES AND GAS TURBINES

**Table 14: Monitoring programme - Gas Engines and Gas Turbines**

| Objective | Detailed Actions | Monitoring Location | Frequency | Responsibility |
|---|---|---|---|---|
| *Construction Phase* | | | | |
| Control of noise emissions from the site | Noise audit of key equipment | Construction site | Once at the start of earth works phase | Environmental officer or independent consultant |
| Monitoring of ambient noise levels | Measurement of noise levels during:<br>1) At the beginning of construction<br>2) Noisiest phase | Boundary of the general construction site | Twice, i.e. at start and during noisiest phase of construction | Environmental officer or independent consultant |
| *Operational Phase* | | | | |
| Monitoring of ambient noise levels | Sampling noise measurements during day- and night-time | At selected points around the perimeter of the CTT operation | Every two years | Environmental officer or independent consultant |
| Maintenance of a complaints register | 1) Discussion at regular meetings<br>2) Identification of source of noise<br>3) Remedial steps<br>4) Feedback to management and complainant | - | Environmental management meetings | Environmental officer |
| *Decommissioning Phase* | | | | |
| Same as construction phase above | | | | |

## 8.0 CONCLUSIONS – GAS ENGINES

The following conclusions are drawn:

- The dominating noise sources are the systems of cooling fans assumed to be installed on the roofs of the power train buildings;
- The overall significance of the noise impact is **low**;
- The maximum noise impact will occur at night when meteorological and other atmospheric conditions favour the propagation of sound over longer distances;
- Under these circumstances a small number of households will be affected; and
- According to Table 5 of SANS 10103 the community reaction to the increase in ambient noise levels will be ‘little’ with ‘sporadic complaints’.

## 9.0 CONCLUSIONS – GAS TURBINES

The following conclusions are drawn:

- The overall significance of the noise impact is **negligible**;
- The maximum noise impact will occur at night when meteorological and other atmospheric conditions favour the propagation of sound over longer distances;
- Even under these circumstances no households will be affected; and
- According to Table 5 of SANS 10103 there will be no community reaction to the increase in ambient noise levels.

## SPECIALIST RECOMMENDATION

Although the noise impact caused by both technologies is limited the consultant prefers the CCGT option due to its considerably smaller noise footprint.

## 10.0 REFERENCES


- Apex Acoustics, Spalding Energy Expansion, Application To Vary The Environmental Permit (EPR/AP3732KC), Noise Impact Assessment, January 2018
- Apex Acoustics, Spalding Energy Expansion, OCGT, Details of the acoustic model, Document 4598.6A, 16th February 2018 Revision A
- Decree 45/2004 (Regulation of Environmental Impact Assessment Process)
- Decree 54/2015 of 31 December 2015 (Environmental Law)
- F le R Malherbe, FMAC Report No. 09/4/1 The Noise Impact of the Wärtsilä Anixas Project on Ambient Noise Levels in Walvis Bay, May 2009
- Golder Associates Report No. MWC268 (December 2012)
- Golder Associates Report No. 1405502-13168-7 Environmental Scope Definition Report & Terms of Reference - Mozambique Gas to Power (CTT) Project, July 2014
- Golder Associates Report No. 1302793 – 10712 – 16 (July 2014)
- Golder Associates Report No. Report No. P1521646 (February 2015)
- Golder Associates Report No. 1659075-306943 (September 2016)
- Guidelines for Community Noise, World Health Organisation, Geneva, 1999.SANS 10103:2008 ‘The measurement and rating of environmental noise with respect to annoyance and to speech communication’, Edition 6.
- International Finance Corporation, General EHS Guidelines: Environmental, 30 April 2007.
- SANS 10103:2008 ‘The measurement and rating of environmental noise with respect to annoyance and to speech communication’, Edition 6.
- SANS 10357:2004 ‘The calculation of sound propagation by the Concawe method’. Edition 1.2.
- Thermal Power: Guidelines for New Plants, Pollution Prevention and Abatement Handbook, WORLD BANK GROUP, Effective July 1998.
- Wärtsilä 50SG Engine Generating Set Product Leaflet, June 2016

# Signature Page

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